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*A Revised List of*  
**PLANT DISEASES**  
occurring in  
**South Africa**

*Compiled by*  
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*To be had from the Division of Plant Industry, Pretoria*

DEPARTEMENT VAN LANDBOU- TECHNIESE DIENSTE.  
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# A REVISED LIST OF PLANT DISEASES OCCURRING IN SOUTH AFRICA,

COMPILED BY

E. M. DOIDGE and A. M. BOTTOMLEY  
(*Division of Plant Industry, Pretoria*).

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THE compilation of a revised list of plant diseases, known to occur in South Africa, was undertaken in accordance with a resolution of the Imperial Agricultural Research Conference held in London in October, 1927, and after a number of unavoidable delays, has now been completed.

We have benefited by the advice of Dr. Butler of the Imperial Bureau of Mycology on many important points, and are indebted to members of his staff for a number of determinations of fungi associated with plant diseases (4). His suggestion that an index of technical names of hosts and parasites be added has been adopted.

The present list is based on a preliminary check list of plant diseases occurring in South Africa, published in 1924 (3). The accuracy of some of the records listed at that time was doubtful, and although there are still a few which are open to question, it has since been possible to check many of the existing records. Some inaccuracies have been eliminated and a number of additional diseases have been observed. Much additional information has been gained through the work of the pathological section of the Division of Plant Industry, and one or two independent investigators. Special work has been done by Moore on tobacco and cotton diseases, by Storey and McClean on virus diseases, by Wager on foot-rots and wilts, by Bottomley on diseases of deciduous and forest trees, and by Doidge on citrus diseases and rust fungi. A considerable number of new records have been supplied by botanists at the Agricultural schools, particularly by Staples, Saunders, Theron, and Gill; for a few occurrences of disease found only in the winter rainfall area of the Cape, we are indebted to a preliminary list of diseases in that area by Verwoerd (6).

Mention may also be made of a paper by Smith and Rattray of Rhodes University College, Grahamstown, on the *Helminthosporium* diseases of Barley (5) read at the Caledon Meeting of the South African Association for the Advancement of Science, 1930.

A conspicuous feature of the present list is the large number of wilt diseases and crown and root rots attributed to species of *Fusarium*. The majority of such organisms have not been specifically determined and the pathogenicity has not been fully proved. Work on this group is now in progress, and it is hoped that more accurate information on wilt diseases of a number of plants will soon be available.

A few records of parasitic flowering plants are included ; for some of these and for assistance in revising the nomenclature of the hosts we are indebted to Miss I. C. Verdoorn. We also wish to acknowledge considerable assistance from Miss S. M. Stent in the revision of the nomenclature of the grasses.

The conditions in different parts of South Africa, sub-tropical and temperate, arid and humid, with summer or winter rainfall, account for the very wide range of cultivated plants listed. Some difficulty was experienced in deciding how many of the indigenous plants should be included. In the case of indigenous trees, only those are included which figure in the reserve list of the Forestry Department and which are considered by them to be of appreciable importance as timber trees. Other indigenous plants included are those of some economic importance as fodder, poisonous, medicinal or ornamental plants. Of the last named, many are cultivated not only in South Africa, but in the gardens of Europe, America and elsewhere.

Bailey's Manual of cultivated plants (1) has been used as a basis of nomenclature for the hosts, and the common names of the diseases are, as far as possible, those adopted in the list prepared by the sub-committee of the British Mycological Society (2). Use has also been made of this publication in revising the names of some of the fungus parasites.

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2. British Mycological Society, Sub-Committee of, List of common names of British Plant Diseases. Trans. Brit. Myc. Soc. XIV., Parts 1 and 2, pp. 140-177, 1929.
3. Doidge, E. M. A preliminary check list of plant diseases occurring in South Africa. Bot. Survey of S. Africa, Memoir No. 6, 1924.
4. Mason, E. W. Annotated account of Fungi received at the Imperial Bureau of Mycology. Lists I-II, 1928.
5. Smith, N. J. G. and Rattray, J. M., Netblotch, Spotblotch and Leaf Stripe. Diseases of Barley in South Africa. Paper read before S. Afr. Ass. Adv. of Sci., Caledon, 1930 ; S. Afr. Jour. Sci. 27, pp. 341-351, 1930.
6. Verwoerd, Len. A preliminary check list of diseases of cultivated plants in the winter rainfall area of the Cape Province. Union Dept., Agric. Sci. Bull. 88, 1929.

#### AGAPANTHUS (*Agapanthus umbellatus* L'Hérit).

##### Leaf Spots

*Macrophoma Agapanthi* Trav.  
*Melanostroma Agapanthi* K. and Cke.  
*Mycosphaerella Agapanthi* Cke

On leaves and peduncles ; localities on the coast from Durban to Capetown.

#### ALMOND (*Prunus communis* Fritsch).

##### Anthracnose

*Gloeosporium amygdalinum* Br.

On green fruit ; occurs occasionally in the South-west Cape Province.

##### Crown Gall.

*Bacterium tumefaciens* Sm. and Towns.

Prevalent throughout fruit-growing areas in all four Provinces.

##### Gummosis

Cause unknown.

Occurs occasionally in the south-west of the Cape Province.

##### Kernel Rot

Cause unknown.

Associated with various moulds ; is a minor trouble in the south-west of the Cape Province.

**Rust** *Puccinia pruni-spinosae* Pers.  
( *Tranzschelia punctata* Arthur).  
On leaves. Fairly common in the late summer wherever almonds are grown.

**Scab** *Cladosporium carpophilum* Thiem.  
On twigs; recorded once only from the Eastern Cape Province.

**Shot-hole** *Cercospora circumscissa* Sacc.  
On leaves. Reported once or twice from the South-western Cape and the Transvaal; is probably fairly prevalent.

**False Silver Leaf** Non-parasitic.  
Occurs fairly commonly in almond orchards in the Cape and Transvaal Provinces; associated with unfavourable conditions.

**Sour Sap** Non-parasitic.  
Occurs in the South-western Cape.

#### **ALOE** (*Aloe* spp).

**Leaf Blotch** *Placoasterella Rehmi* (P. Henn.)  
Th. and Syd.  
A superficial blemish reported occasionally from the Cape, Transvaal, and Natal; not serious.

**Rust** *Uromyces Aloes* Cke.  
Widespread; is most severe in cultivated aloes growing under unsuitable cultural conditions, e.g., excessive moisture, overcrowding, too much shade; may cause considerable damage.

**Scab, Black Leaf Spot** *Montagnella maxima* Mass.  
Reported from the Cape and Transvaal, and observed to be seriously attacking aloes near Port Elizabeth.

#### **AMATUNGULA** (*Carissa grandiflora* D.C.).

**Black Spot** *Macowanella congesta* Doidge.  
Attacks leaves and stems; only recorded from Natal, the natural habitat of the plant. This fungus is extremely common and widespread on the "num-num" (*Carissa arduina* Lam.).

**Damping off** *Rhizoctonia* sp.  
Found attacking seedlings under greenhouse conditions.

#### **ANTHOLYZA** (*Antholyza aethiopica* L).

**Rusts** *Uromyces kentaniensis* Doidge;  
*Aecidium Antholyzae* Bubak.  
Only one record of each from the Transkei. Have also been reported from South-western Cape.

**APPLE** (*Pyrus malus* L.).**Apple Branch Blister, Puisiesiekte** *Coniothecium chomatosporum* Cda.

On branches and twigs. Prevalent throughout South Africa, especially in the Transvaal. The disease is capable of causing considerable damage and would appear to be increasing in severity. It is most severe when the trees are weak from some cause, or when unsuitable varieties are grown.

**Apple Cracking Disease** *Coniothecium chomatosporum* Cda.

On fruit; occurs at times in most of the apple growing areas; often associated with unfavourable climatic or cultural conditions.

**Bitter Pit** Non-parasitic.

Widely distributed, but sporadic in occurrence, depending to a certain extent on climatic conditions; largely a disease of young trees.

**Bitter Rot** *Glomerella cingulata* (Stonem.) Spauld and Schrenk. (= *Gloeosporium fructigenum* Berk.)

On fruit. Most prevalent in the Eastern Cape Province, but also occurs in the midlands of Natal and in the Eastern Transvaal. Does not seem to cause serious damage.

**Black Rot Canker** *Phylospora Cydoniae* Arnaud.

On leaves and fruit; fairly widespread throughout the Cape, Natal, and the Transvaal, but is not very severe.

**Blue Mould** *Penicillium expansum* (Lk.), emend. Thom.

Causes rot in apples in cold storage.

**Brown Rot** *Sclerotinia fructigena* (Pers.) Schroet.

On twigs and only of very occasional occurrence.

**Canker** *Botryosphaeria Ribis* G. and D. var *chromogena* (= *Dothiorella mali* E. and Z.).

Occurs in the Transvaal and the Eastern Cape Province, but is most prevalent in the Transvaal; has occasionally caused serious damage.

**Canker** *Fusicoccum africanum* v. d. Byl.

Reported from Stellenbosch, Cape Province.

**Canker** *Nectria galligena* Bres.

Occurs occasionally in the Orange Free State, Natal, and Transvaal, but is of minor importance in South Africa.

**Chlorosis** Non-parasitic.

This trouble is common and widespread. It is often associated with excessive alkalinity of the soil.

**Crown Gall, Hairy Root** *Bacterium tumefaciens* Sm. and Towns.

Is not of great importance on the apple. Burr knots on the stems of some varieties and "hairy roots" characteristic of the Northern Spy Stocks are often mistaken for Crown Gall.

**Die Back**

*Falsa leucostoma* (Pers.) Fr.  
(= *Cytospora leucostoma* Sacc.).

On branches and trunks. Widely distributed but apparently most severe in the South-west Cape Province, Orange Free State, and Transvaal. Usually attacks trees which are in poor condition: the *Cytospora* stage only of the fungus is usually developed.

**Fly Speck**

*Leptothyrium Pomi* (Mont. and Fr.)  
Sacc.

On fruit: develops under humid conditions and is most abundant in areas with a late summer rainfall. It has been recorded from the Eastern Cape Province, but is most prevalent in the more humid parts of Natal and the Northern Transvaal. Usually of minor importance.

**Fruit Spot**

*Phoma pomi* Pass.

On fruit: this disease has only been noted in one or two localities in the Transvaal and Eastern Cape Province, but there is reason to believe that it is more prevalent than this would indicate. The development of the fungus is arrested under cold storage conditions, but in ordinary storage the disease may give rise to serious breakdown.

**Glassiness, Water-core**

Non-parasitic.

This trouble occurs sporadically throughout the four Provinces, but is not usually of much importance. Like Bitter Pit it is correlated with certain climatic conditions and sometimes occurs with the latter on young trees, 5-7 years old.

**Hairy Root**

*Bacterium tumefaciens* Sm. and Towns.

See Crown Gall.

**Measles**

Non-parasitic.

On twigs and branches. Known to be widely distributed in the Eastern Cape and Transvaal, and probably occurs elsewhere as well: said to do considerable damage in the Eastern Cape. Characterised by the presence of small raised blisters, which correspond with minute corky lesions in the bark. Cause unknown, but often associated with unsuitable varieties or soil conditions. Some varieties, e.g., White Winter Pearmain, are more susceptible than others.

**Mildew**

*Podosphaera leucotricha* (E. and E.)  
Salm.

On foliage and young shoots. Very common and widely distributed. This disease appears to be on the increase and in some seasons causes serious damage to both old and young trees.

**Mistletoe, Vuurhoutjes**

*Loranthus oleifolius* Ch. and Sch.

Observed in the Northern Transvaal.

**Mouldy Core**

Various moulds, mainly *Penicillium*  
spp., *Aspergillus* sp.

Known to occur in several districts of the Western Cape Province and in the Transvaal. Usually in varieties with open cores which give access to mould spores.

**Pink Disease***Corticium laetum* Karst.

On twigs and branches. A wound parasite; becomes an active parasite under moist conditions; occurs in the mist belt in Natal.

**Pink Rot***Cephalothecium roseum* (Fr.) Cda.

On fruit. Attacks apples infected with scab, bitter rot, or other diseases. Sometimes found on fruit exposed for sale.

**Scab***Venturia inaequalis* (Cke.) Wint.

[=*Fusicladium dendriticum* (Wallr.) Fckl.].

On fruit and leaves in the Cape, Natal, and Transvaal, but apparently most prevalent in the Cape and the Northern Transvaal.

**Sclerotium Disease***Sclerotium Rolfsii* Sacc.

Attacks the crown of nursery and orchard trees, causing death. Prevalent in parts of Natal and the Transvaal and occurs at times in the Cape. Trees in heavy wet soils are the most susceptible. Is a serious trouble in some Natal nurseries.

**Sooty Blotch***Gloeodes pomigena* (Schw.) Coll.

Fungus not identified with certainty. See Fly Speck, with which it is often associated on the fruit.

**Sour Sap**

Non-parasitic.

In the South-western Cape Province.

**Sun Scald**

Non-parasitic.

On fruit; due to the heat of the sun and hot dry winds. Most troublesome in the Cape, but occurs at times in the Transvaal and Orange Free State.

**Surface Canker, Superficial Bark Canker** *Myrosporium corticolum* Edgerton.

Natal and Transvaal; causes die-back at times but is of minor importance.

**Trunk Rot***Schizophyllum commune* Fr.

Transvaal and South-western Cape: A wound parasite, often following sunburn injury.

**APRICOT** (*Prunus Armeniaca* L.).**Brown Rot***Sclerotinia fructigena* (Pers.) Schr.

On mummified and fresh fruit; only reported during one exceptionally wet season in the Western Cape Province.

**Chlorosis**

Non-parasitic.

Widely distributed, but most prevalent in the South-west Cape, where, in some localities, it is proving a limiting factor in the growing of apricots. Associated with various soil deficiencies and conditions.

**Crown Gall***Bacterium tumefaciens* Sm. and Towns

On roots and crown; widely distributed and may cause considerable damage, especially when trees are grown on peach stocks. Occasionally attacks twigs injured by hail.



- Die Back** *Valsa leucostoma* (Pers.) Sacc.  
( *Cytospora leucostoma* Sacc.).  
On branches and trunks, in the Cape, Transvaal, and Orange Free State.  
Appears only to attack trees which are in poor condition.
- Freckle** *Cladosporium carpophilum* Thum.  
On fruit, leaves, and twigs; widely distributed throughout the country  
and particularly severe in the Transvaal. May be very serious in  
the fruit, distorting and disfiguring the whole crop.
- Rust** *Puccinia pruni-spinosae* Pers. [ *Tranzschelia punctata* (Pers.) Arth.].  
On leaves and occasionally on fruit; probably occurs on the late summer  
in most orchards. The fruit infection has only been reported from the  
Eastern Cape. Not usually sufficiently severe to cause appreciable  
damage.
- Shot Hole** *Bacterium pruni* Erw. Sm.  
Found on leaves in the Eastern Cape Province.
- Shot Hole** *Cercospora circumscissa* Sacc.  
On leaves; only recorded from the Eastern Transvaal, but is probably  
more prevalent than this would indicate. Does not cause serious injury.
- Shot Hole** *Phyllosticta prunicola* (Op.) Sacc.  
On leaves: Basutoland.
- Silver Leaf** *Stereum purpureum* Fr.  
Fairly widely distributed in the orchards of the Western Cape Province,  
but not reported as causing serious injury.
- Sour Sap** Non-parasitic.  
Fairly prevalent, but apparently not serious.
- Trunk Rot** *Polyporus proteus* Kalch.  
(= *Polystictus proteiformis* Cke.).  
Only known from Wellington in the Cape Province.
- Trunk Rot** *Schizophyllum commune* Fr.  
Not very common or important: reported only from Wellington in the  
South-western Cape and Potgietersrust in the Transvaal.

## **ARAUCARIA** (*Araucaria* spp.).

- Leaf and Twig Blight** *Pestalozzia funerea* Desm.  
Reported only from Zululand.
- Fusarium Wilt** *Fusarium* sp.  
Sometimes attacks seedlings in the nursery.

## **ARTICHOKE** (*Helianthus tuberosus* L.).

- Tuber and Storage Rot** *Acremonium* sp.  
Occurs occasionally in South-western Cape and Northern Transvaal:  
Also found in a consignment imported from Lisbon.

**ARUM** (*Zantedeschia* spp.).**Leaf Spot** *Septoria Ari* Desm.

Common throughout the South-western Cape, where it may do considerable damage in wet seasons.

**Mildew** *Oidium* sp.

Known to occur in the Transvaal; of minor importance.

**Rust** *Aecidium ari* Desm.

One record. Malvern, Natal.

**ASPARAGUS** (*Asparagus officinalis* L.). See also **WILD ASPARAGUS**.**Wilt** *Fusarium* sp.

One record, from Kimberley: Asparagus is not at present cultivated extensively.

**ASSEGAI WOOD** (*Curtisea faginea* Ait.).**Leaf Mould** *Meliola ganglifer* Kalch.

Common in all indigenous forests where the host occurs.

**Trunk Rot** *Fomes applanatus* (Pers.) Gill.;  
*F. Yucatanensis* (Murr.) Sacc.

Observed on this tree in the Eastern Cape Province.

**ASTER** (*Callistephus chinensis* Nees).**Dodder** *Cuscuta arvensis* Beyr.

Occasional. Found in the Pretoria district and probably occurs elsewhere.

**Fusarium Wilt** *Fusarium conglutinans* Wr. var *Callistephi* Beach.Fairly widely distributed, and occasionally severe when conditions are suitable for its development. Other species of *Fusarium* may be involved.**AVOCADO** (*Persea americana* Mill).**Anthracnose** *Colletotrichum gloeosporioides* Penz.

On fruit: Fairly common in the Eastern Transvaal.

**Leaf Spot** *Phyllosticta Perseae* E. and M.

On seedlings at Irene, Transvaal.

**Canker** *Phyalospora Perseae* Doidge.

Causing serious stem cankers near Louis Trichardt, Northern Transvaal.

**Root-rot and Die Back** *Phytophthora cambivora* Petri.

In the Eastern Transvaal; associated with the above fungus, but pathogenicity of organism not proved.

**Scab** *Sphaeceloma* sp.

Causes extensive brown scabbing of fruit, usually on areas remote from stem end. Pathogenicity of the organism not yet proved.

**BABALA GRASS.** See **PEARL MILLET.**

**BABIANA, BABIAANTJE** (*Babiana* spp.).

**Rust** *Uromyces Babianae* Doidge.  
On *B. disticha* Ker. and *B. stricta* (Vit.), Ker., Cape Province.

**BAMBOO** (*Bambusa* sp.).

**Leaf Spot** *Helminthosporium* sp.  
At Stellenbosch, Cape.

**BANANA** (*Musa sapientum* L.).

**Anthraxnose** *Gloeosporium musarum* Cke. and Mass.  
On fruit, occurring commonly on the Natal Coast: elsewhere it is found on fruit exposed for sale. Causes rapid decay of the fruit under favourable conditions.

**BARBERTON DAISY** (*Gerbera Jamesoni* Hk.).

**Leaf Spot** *Septoria Gerberae* Syd.  
Widespread and common on wild and on cultivated plants. May do considerable damage if allowed to go unchecked.

**White Blister** *Cystopus cubicus* de By  
On leaves. Common on cultivated plants in Natal and Transvaal.

**BARLEY** (*Hordeum* spp.).

**Black Rust** *Puccinia graminis* Pers.  
On leaves and culms. Widely distributed through the cereal-growing districts.

**Covered Smut** *Ustilago hordei* (Pers.) Kell. and Sw.  
On blades and culms. Widely distributed, particularly in South-west Cape Province.

**Foot Rot** *Helminthosporium sativum* P.K. and B.  
Has been found in only a few localities in the Eastern and Western Cape Province, but is probably more widely distributed. May cause considerable damage.

**Leaf Stripe, Leaf Blotch** *Helminthosporium gramineum* Rabh.  
Has been collected in the Transvaal and the Eastern Cape Province. There is no evidence that this disease causes serious damage.

**Loose Smut** *Ustilago nuda* (Jens.) Kell. and Sw.  
In spikelets: Widely distributed in the Western Cape Province.

**Mildew** *Erysiphe graminis* D.C.  
On leaves and culms: Occurs in the Eastern Cape Province and in the Pretoria District, Transvaal: but is most widely distributed in the Western Cape districts.

**Net-blotch** *Pyrenophora teres* (Died.) Drechs.  
(=*Helminthosporium teres* Sacc.).

Has been collected in Natal, Transvaal, and in Eastern and Western Cape Province. Said to be one of the commonest barley diseases in the Union.

**Take-all, Whiteheads, Vrotpootje** *Ophiobolus graminis* Sacc.  
[=*Ophiobolus cariceti* (B. and Br.) Sacc.].

Known to occur in the South-west Cape, but is not of much importance.

## **BEET** (*Beta vulgaris* L.).

**Heart Rot** *Phoma Betae* (Oud.) Fr.

On sugar beet; only known in experimental plots in the Transvaal.

**Leaf Spot** *Cercospora beticola* Sacc.

Common wherever this crop is grown.

**Mosaic** Virus.

Reported from Stellenbosch, Cape.

**Rhizoctonia Root Rot** *Rhizoctonia* sp.

Only known on sugar beet in experimental plots, Transvaal.

**Rust** *Uromyces Betae* (Pers.) Tul.

Occurs throughout the four provinces, and under favourable conditions does considerable damage to the crop.

**Sclerotium Rot** *Sclerotium Rolfsii* Sacc.

On sugar beet; only recorded from the Transvaal.

## **BERMUDA GRASS** (*Cynodon dactylon* Pers.).

**Black Spot** *Phyllachora Cynodontis* (Niessl.) Sacc.  
Common and widely distributed.

**Ergot** *Claviceps* sp.  
Common in the Transvaal and also occurs in the Cape.

**False Ergot** *Balansia* sp.  
Very common in the Transvaal, causing abnormal elongation of the internodes.

**False Smut** *Cerebella Cynodontis* Syd.  
Not common. Occurs in Transvaal and Cape Provinces.

**Grey Mould** *Phyvarum cinereum* Pers.,  
*Ph. verum* Somm.  
Common in the Transvaal.

**Rust** *Puccinia Cynodontis* Desm.  
Widespread and of common occurrence.

**Smut** *Ustilago Cynodontis* P. Henn.  
Widespread and of common occurrence.

**BERSAMA** (*Bersania lucens* Szysz.).

- Black Spot** *Phyllachora Melianthi* (Thunb.) Sacc.  
One record from Kentani, Transkei.

**BLACKBERRY** (*Rubus* sp.). See also under **BRAMBLE**.

- Rust** *Kuehneola albida* (Kühn) Magn.  
[ = *Phragmidium violaceum*  
(Sch.) Wint.].

Said to occur in the Knysna District.

- Crown Gall** *Bacterium tumefaciens* Sm. and Towns.  
Reported from Stellenbosch, Cape.

- Leaf Spot** *Septoria Rubi* West.  
Common in the Western Cape Province.

**BLACK JACK** (*Bideus pilosa* L.).

- Mildew** *Sphaerotheca humuli* (D.C.) Burr. var.  
*fuliginea* (Schl.) Salm.

Of frequent occurrence.

- Rust** *Uromyces Bidentis* Lagh.  
Common and widely distributed.

**BLAUWBEKKIE** (*Heliophila* spp.).

- White Rust** *Cystopus caudatus* (Pers.) de By.  
var. *Heliophilae* P. Henn.

Recorded once at Capetown.

**BLAAUSAADGRAS** (*Eragrostis curvula* Nees.).

- Black Spot** *Phyllachora* sp.  
Reported from Stellenbosch, Cape.

**BOEKENHOUT.** See **CAPE BEACH.****BRAMBLE** (*Rubus* spp.).

- Leaf Mould** *Irene calostroma* (Desm.) v. Höhn.  
Common in the forest areas of Natal, Cape, and Transvaal.

- Rust** *Hamaspora longissima* (Thunb.) Koern.  
Very common and widespread.

- Rust** *Kuehneola albida* (Kuehn.) Mgn.  
Transvaal and Cape Provinces.

**BRINJAL.** See **EGG FRUIT.**

**BROAD BEAN** (*Vicia Faba* L.).

**Bacterial Blight** *Bacterium Phaseoli* Erw. Sm.

On leaves. Only one occurrence on record at Pretoria, Transvaal.

**Fusarium Wilt** *Fusarium* sp.

Only recorded from Pretoria, Transvaal.

**Leaf Spot, Blight** *Alternaria* sp.

On leaves; reported from Cedara, Natal, Pretoria, and South-western Cape Province. Very destructive at times.

**Rust** *Uromyces Fabae* (Pers.) De By.

On leaves, stems, and pods; widespread and may be very destructive.

**BROME.** See **RESCUE GRASS.****BRUSSELS SPROUTS** (*Brassica oleracea* L. var. *gemmifera* Zenk.).

See under **CABBAGE.**

**BUCHU** (*Barosma* spp.).

**Leaf Mould** *Meliola microthecia* Thuem.

Eastern Cape Province. Not very common.

**Root Rot** Cause unknown.

Occurs in the South-western Cape.

**BUFFEL GRASS** (*Pennisetum cenchroides* Rich.).

**Smuts** *Sorosporium* sp.,  
*Ustilago Penniseti* Rabh.

Cape and Transvaal.

**BUFFELSBAL.** See **CANDLEWOOD.****BUIG-MY-NIE.** See **CAPE BOX.****BUSH WILLOW, ROOIBLAAR** (*Combretum erythrophyllum* Sond.).

**Trunk Rot** *Polyporus lucidus* (Leys) Fr.,  
*P. gilvus* Schwein.

Pretoria, 1929.

**CABBAGE, CAULIFLOWER ETC.** (*Brassica oleracea* L.).

**Bacterial Spot** *Bacterium maculicolum* McC.

Prevalent in the Cape and Transvaal.

**Black Mould** *Alternaria Brassicae* (Berk) Sacc.

Reported from Godwan River, Transvaal, and Warner Beach, Natal.

**Black Rot** *Bacterium campestre* (Pam.) Erw. Sm.

very common and widespread; often causes serious damage

- Downy Mildew** *Peronospora parasitica* (Pers.) Tul.  
Occasionally destructive in the seed bed; Natal and Eastern Transvaal.
- Finger and Toe, Club Root, Dik Voet** *Plasmodiophora Brassicae* Wor.).  
Occurs in Cape, Transvaal, and Orange Free State; more common in the South-west Cape than elsewhere.
- Foot Rot, Stem Rot, Black Leg** *Phoma Lingum* (Tode) Desm.  
( *Ph. Napobrassicae* Rostr.)  
and *Ph. oleracea* Sacc.  
Fairly prevalent in the Cape, Natal, and Transvaal.
- Fusarium Wilt** *Fusarium* sp.  
Eastern Transvaal. Not common, cabbage being largely a winter crop in the warmer districts.
- Leaf Spot** *Ascochyta* sp.  
From one locality in Natal.
- Ring Spot** *Mycosphaerella brassicicola* (Fr.) Lind.  
Occurs in South-western Cape.
- Stump Rot** *Bacillus carotovorus* Jones.  
Sometimes following black rot.

**CABBAGE WOOD** (*Cussonia spicata* Thun.).

- Leaf Mould** *Meliola leptidea* Syd.  
In the forests of Northern Transvaal.
- Rust** *Aecidium Cussoniae* Kalch.  
Only one record from Natal.

**CAMEL THORN, KAMEELDORING** (*Acacia Giraffae* Burch.).

- Black Spot** *Hysterographium Acaciae* Doidge.  
On bark of the tree in the Boshoff District, O.F.S.

**CANARY GRASS** (*Phalaris bulbosa* L.).

- Leaf Blight** *Alternaria* sp.  
A heavy infection occurred at Cedara, some years ago.
- Ergot** *Claviceps* sp.  
A heavy infection sometimes occurs in Natal and Transvaal.

**CANDLEWOOD, WILD GARDENIA, BUFFELSBAL, WILDE KATJEPIERING**  
(*Gardenia Rothmannia* L. f.).

- Leaf Mould** *Meliola littoralis* Syd.  
Natal and Northern Transvaal.

**CANNA** (*Canna indica* L.).

- Fusarium Wilt** *Fusarium* sp.  
Reported only from George, Cape. Not common.

**CALABASH** (*Lagenaria leucantha* Rushby.).

**Mosaic** Virus.  
Reported from Verulam, Natal.

**CAPE BEECH, BOEKENHOUT** (*Myrsine melanophloeos* R. Br.).

**Leaf Mould** *Macowaniella myrsinicola* Doidge.  
On leaves. Natal and George District, Cape.

**Black Spot** *Phyllachora myrsinicola* Doidge.  
Found in Natal.

**Black Coral Spot** *Corynelia fruticola* (Pat.) v. Hohn.  
On fruits, Natal and Transvaal.

**CAPE BOX, BUIG-MY-NIE** (*Buxus MacOwani* Oliv.).

**Leaf Mould** *Meliola buxicola* Doidge.  
East London and Alexandria, Cape.

**CAPE GOOSEBERRY** (*Physalis peruviana* L.).

**Leaf Spot** *Entyloma Physalidis* (K. and Cke.) Wint.  
Common wherever this plant is grown, but not usually destructive.

**CAPE HOLLY** (*Ilex mitis* Radlk.).

**Leaf Moulds** *Englerulaster orbicularis* (B. and C.) v. Höhn, *Asterina Hendersoni* Doidge.  
The former is common in the forests of Natal, Cape, and Transvaal.

**CAPE SMILAX** (*Asparagus medeoloides* Thun.).

**Rust** *Puccinia Myrsiphylli* (Thuem.) Wint.  
Several records from Natal.

**CARNATION** (*Dianthus caryophyllus* L.).

**Crown Rot** *Rhizoctonia* sp.  
Prevalent in Transvaal and Orange Free State. May be very destructive.

**Fairy Ring Disease, Ring Spot** *Heterosporium echinulatum* (Berk.) Cke.  
Not common; only known in Natal and the South-western Cape.

**Fusarium Wilt** *Fusarium* sp.  
Widespread and prevalent; very destructive in parts of Natal and Transvaal.

**Leaf Rot** *Volutella Dianthi* Atk.  
Serious in the Northern Transvaal; aggravated by faulty cultural practices.



**Leaf Spot** *Alternaria Dianthi* S. and H.  
( *Macrosporium Dianthi* S. and H.).  
Occurs in South-western Cape, Natal, and Transvaal. Destructive in wet seasons.

**Leaf Spot** *Ascochyta Dianthi* (Alb. and Schw.) Berk.  
Not common. Occurs occasionally in the Eastern Cape Province.

**Leaf Spot** *Phyllosticta Dianthi* West.  
Not common. Reported only from Pyramids, Transvaal.

**Leaf Spot** *Septoria Dianthi* Desm.  
Fairly prevalent in Transvaal, Natal, and Cape. Not usually destructive.

**Root Rot** *Sclerotium Rolfsii* Sacc.  
Occurs in Transvaal : occasionally destructive.

**Rust** *Uromyces caryophyllinus* (Schrank) Wint. [ = *U. Dianthi* (Pers.) Niesst].  
Prevalent wherever carnations are grown ; also occurs on indigenous species of *Dianthus*.

#### **CARROT** (*Daucus carota* L.).

**Blight** *Alternaria Brassicae* (Berk.) Sacc.  
Fairly prevalent in Natal ; may do considerable damage under moist conditions.

**Root disease** *Phoma sanguinolenta* Rostr.  
Reported from Celara, Natal : not common.

**Soft Rot** *Rhizopus* sp.  
A common storage rot.

#### **CASTER OIL** (*Ricinus communis* L.).

**Crown Gall** *Bacterium tumefaciens* Sm. and Town.  
Said to have occurred at the Elsenburg Experiment Station, Cape.

**Rust** *Melampsora Ricini* Pass.  
In Transvaal and Cape Provinces : widespread but does not seem to be destructive. Teleutospores unknown.

#### **CAULIFLOWER.** See **CABBAGE.**

#### **CELERY** (*Apium graveolens* L.).

**Leaf Spot** *Septoria Apii* Chester (= *S. Petroselinii* Desm. var. *Apii* Br. and Cav.).  
Fairly prevalent in Cape, Transvaal and Natal.

#### **CHERRY** (*Prunus cerasus* L.).

**Brown Rot** *Sclerotinia cinerea* Schroet.  
Recorded from the Cape Province only.

- Crown Gall** *Bacterium tumefaciens* Sm. & Towns.  
Widely distributed, but apparently not of much importance on this host.
- Leaf Spot** *Ascochyta* sp.  
Reported from Belfast, Transvaal.
- Leaf Spot** *Cylindrosporium padi* Karst.  
Reported from Belfast, Transvaal.
- Shothole** *Cercospora circumscissa* Sacc.  
Said to occur at Stellenbosch, Cape.
- Sour-sap** Non-parasitic.  
Said to occur at Stellenbosch, Cape.
- Trunk Rot** *Schizophyllum commune* Fr.  
Reported from Koelenhof, Cape.

**CHERRYWOOD, KERSHOUT** (*Pterocelastrus variabilis* Meisn.).

- Leaf Mould** *Asterinella Pterocelastri* Doidge.  
On leaves. Knysna District, Cape.

**CHICORY** (*Cichorium Intybus* L.).

- Bacterial Blight** Organism not identified.  
Reported from Alexandria, Cape; said to be very destructive.
- Rust** *Puccinia Cichorii* (D.C.) Bell.  
Reported from Sea Point and Alexandria, Cape; only the uredo-stage seen.

**CHILLI** (*Capsicum frutescens* L.).

- Bacterial Wilt** *Bacterium solanacearum* Erw. Sm.  
Said to occur at Stellenbosch, Cape.
- Sclerotium Wilt** *Sclerotium Rolfsii* Sacc.  
Fairly prevalent and destructive in Eastern Transvaal.

**CHINKERICHEE** (*Ornithogalum thyrsoides* Jacq.).

- Rust** *Puccinia Ornithogali-thyrsoides* Diet.  
Occurs in Cape Province.

**CHRYSANTHEMUM** (*Chrysanthemum* spp.).

- Fusarium Wilt** *Fusarium* sp.  
Caused wilt in young plants at Pyramids, Transvaal. Not common.
- Leaf Blight** *Cylindrosporium Chrysanthemi* Ell.  
and Desm.  
Said to occur in Maritzburg, Natal.

- Leaf Spot** *Septoria chrysanthemella* Sacc.  
Prevalent throughout South Africa. Very destructive in the summer rainfall areas.
- Mildew** *Oidium Chrysanthemi* Rabh.  
Fairly common.
- Rust** *Puccinia Chrysanthemi* Roze.  
Common and widely distributed: very destructive at times.
- CLARKIA** (*Clarkia* sp.).
- Wilt** Organism not determined.  
Reported from Rosebank, Cape.
- CLOVER** (*Trifolium* sp.).
- Leaf Spot** *Pseudopeziza Trifolii* (Biv. and Bern.) Fekl.  
Only one occurrence recorded in the Transvaal.
- COCKSCOMB** (*Celosia argentea* L. var *cristata* Kze.).
- Fusarium Wilt** *Fusarium* sp.  
Only one record. Norvalspont, Cape.
- COCKSFOOT** (*Dactylis glomerata* L.).
- Leaf Blight** *Clasterosporium claratum* Lév.  
Occurs at Pretoria, Transvaal.
- Rust** *Puccinia graminis* Pers.  
Occurs in the Transvaal.
- COFFEE** (*Coffea* spp.).
- Berry Spot** *Macrosporium* sp.  
Occurs in Northern Transvaal, but is apparently not common.
- Rust** *Hemileia vastatrix* Berk. & Br.  
In Natal and Northern Transvaal. Many years ago coffee-growing as a commercial enterprise was abandoned in these areas, chiefly owing to the ravages of this disease. An attempt is now being made to revive the industry and to establish resistant varieties.
- COFFEE PEAR** (*Pleurostyliia capensis* Oliv.).
- Leaf Moulds** *Parasterina reticulata* Doidge, *Irene ditricha* (K. and Cke.) Doidge.  
The former is common on this host and a number of other species of *Celastrineae* in Natal, Eastern Cape and George District.
- COLUMBINE** (*Aquilegia* spp.).
- Mildew** *Oidium* sp.  
Fairly prevalent in the South-western Cape, and probably fairly widely distributed.

**CORNFLOWER** (*Centaurea Cyanus* L.).

- Fusarium Wilt** *Fusarium* sp.  
One record only from Johannesburg.
- Rhizoctonia Wilt** *Rhizoctonia* sp.  
In the Eastern Transvaal.
- Rust** *Puccinia Cyani* (Schl.) Pass.  
Said to be fairly destructive in the neighbourhood of Durban, Natal.

**COSMOS** (*Cosmos bipinnatus* Cav.).

- Dodder** *Cuscuta arvensis* Beyr.  
Occasional; occurs in Pretoria District and possibly elsewhere.
- Fusarium Wilt** *Fusarium* sp.  
Said to occur at Stellenbosch, Cape.
- Mildew** *Sphaerotheca humuli* (D.C.) Burr.  
var. *fuliginea*.

**COTTON** (*Gossypium* sp.).

- Angular Leaf Spot, Bacterial Bollrot, Black Arm** *Bacterium malvacearum* Erw. Sm.  
Present in all cotton districts, attacking seedlings, leaves and bolls. May cause severe injury under continued damp conditions.
- Anthraxnose** *Glomerella Gossypii* (South) Edg.  
Common, but not usually serious.
- Black Mould** *Macrosporium* sp.  
Occurs on leaves and bolls, probably as a secondary parasite. Not uncommon in cotton areas.
- Boll Rot** *Fusarium* sp.  
Common.
- Damping off** *Fusarium* sp.  
Seen in experimental plants; field occurrence uncertain.
- Internal Boll Rots** *Nematospora Gossypii* Moore,  
*N. Coryli* Pegl.  
There is only one record of *N. Coryli* from the Transvaal, but *N. Gossypii* is common throughout the more humid parts of the cotton belt; causing heavy losses in association with stainer bugs.
- Leaf Spot** *Alternaria* sp.  
Occasional; locally serious.
- Root Rot** *Rhizoctonia* sp.  
Common on seedlings.
- Root Rot** *Thielaviopsis basicola* (Berk.) Ferr.  
Serious locally.

**Sclerotium Wilt** *Sclerotium Rolfsii* Sacc.

Recorded from a few localities; not important.

**Wilts** Cause unknown.

These are associated with *Fusarium* spp. and *Phoma* spp. and are under investigation. Important in certain areas, and occurring occasionally in all cotton areas.

**COWPEA** (*Vigna catjang* Wolf.).

**Anthracnose** *Glomerella lindemuthianum* (Sacc. and Magn.) Shear.

Severe in experimental plots at Cedara, Natal.

**Bacterial Leaf Spot** Organism not determined.

Reported from Transvaal, Natal and Orange Free State.

**Leaf Blotch** *Cercospora cruenta* Sacc.

Reported from Maritzburg, Natal.

**Leaf Spot** *Ascochyta Pisi* Lib.

Very destructive in Natal where, in the more humid areas, it is a limiting factor in the growth of this crop.

**Leaf Spot** *Phyllosticta* sp.

Occurs in Natal and Transvaal; not important.

**Mildew** *Erysiphe Polygoni* D.C.

In the more humid parts of Natal and Eastern Transvaal; not important.

**Root Parasites** *Melasma (Alcetra vogelii* Benth.),  
*Melasma sessiliflorum* Benth.

The former species occurs in Northern Transvaal. *M. sessiliflorum* is said to be becoming a serious pest in Northern Natal.

**Root and Pod Rot** *Corticium solani* Bourd and Galz.

Occurs in Natal; not important.

**Rust** *Uromyces appendiculatus* (Pers.) Lk.

Natal and Eastern Cape; not important.

**Sclerotium Wilt** *Sclerotium Rolfsii* Sacc.

Natal and Transvaal; of minor importance.

**CROTON** (*Croton sylvaticum* Hochst.).

**Black Spot** *Phyllachora Crotonis* (Cke.) Sacc.

Found in Natal.

**Rust** *Schroeteriaster stratosus* (Cke.) Syd.

Found fairly commonly near the Natal coast.

**CUCUMBER** (*Cucumis sativus* L.).

**Anthracnose** *Colletotrichum lagenarium* (Pass.) Ell.  
and Hals.

Said to occur at Stellenbosch, Cape.

- Downy Mildew** *Pseudoperonospora cubensis* B. and C.  
Occurs in Eastern and Northern Transvaal and Eastern Cape. Not common.
- Mildew** *Erysiphe cichoracearum* D.C.  
Prevalent throughout South Africa: Destructive in the summer rainfall areas.
- Mosaic** Virus.  
Fairly common.

**CUSTARD APPLE** (*Annona reticulata* L.).

- Collar and Trunk Rot** Cause unknown.  
Reported from Little Brak River, Cape.
- Leaf Spot** *Colletotrichum annonicola* Speg.  
Said to occur at Stellenbosch, Cape.

**CYCLAMEN** (*Cyclamen indicum* L.).

- Bulb Rot** *Botrytis cinerea* Auct.  
Reported from Capetown.
- Leaf Spot** *Phyllosticta* sp.  
Said to occur at Stellenbosch, Cape.

**CYPRESS** (*Cupressus* spp.).

- Die Back** *Phomopsis juniperovora* Hahn.  
Occasionally destructive.
- Leaf and Stem Blight** *Pestalozzia funerea* Desm.  
Fairly common in Transvaal; not usually destructive.
- Trunk Rot** *Polyporus gilvus* Schw.  
Graskop, Transvaal.
- Root Rot** *Xylaria* sp.  
On hedge plants, Transvaal.

**DAGGA.** See **HEMP**.

**DAHLIA** [*Dahlia variabilis* (Willd.) Des.].

- Dry Rot** Cause unknown.  
Port Elizabeth, Cape.
- Leaf Spot** *Entyloma Dahliae* Syd.  
Natal and Cape. Very prevalent in Natal in wet seasons.
- Tuber Rot** *Sclerotium ? Rolfsii* Sacc.  
Reported from Durban, Natal.

**DAFFODIL** (*Narcissus pseudonarcissus* L.).

- Bulb Rot** Cause unknown.  
Occurs in South-Western Cape.

**DELPHINIUM** (*Delphinium* sp.).**Bacterial Wilt**

Organism undetermined.

Reported from Richmond, Natal.

**Mildew***Erysiphe Polygoni* D.C.

Common and widespread; destructive under conditions favourable to development of fungus.

**DODONAEA** (*Dodonaea viscosa* L.).**Nooishaar***Cassytha ciliolata* Nees.Found seriously infesting *Dodonaea* hedges in Johannesburg.**DWARF BEAN.** See **FRENCH BEAN.****EGG PLANT** (*Solanum melongena* L. var. *esculentum* Nees.).**Bacterial Wilt***Bacterium solanacearum* Erw. Sm.

Natal and Transvaal; may be destructive.

**ELEPHANT GRASS.** See **NAPIER FODDER.****EUCALYPTUS** (*Eucalyptus* spp.).**Heart Rot***Stereum hirsutum* Fr.Parasitic on *Eucalyptus globulus* Lab. at Cliffondale nr. Roo-depoort, Transvaal.**Leaf Spot***Lembosioopsis eucalyptina* Pet. and Syd.

Fairly common in plantations.

**Other Fungi***Armillaria mellea* Vahl., *Cytospora Australiae* Speg., *Fomes annosus* Fr., *Harknessia uromycoides* Speg.

Occur occasionally, not important.

**FIG** (*Ficus carica* L.).**Anthracnose***Colletotrichum Carica* S. and H.

Occurs in the Cape, Transvaal and Natal, causing some dropping of the fruit at times.

**Die Back***Phoma* sp.

Reported from the Transvaal on several occasions; not important.

**Leaf Blotch***Cercospora bolleana* (Thuem.) Speg.

Occasional in the Cape and Transvaal; not important.

**Fruit Spot**

Cause unknown.

Causes premature dropping; several records from the South-western Cape

**Mistletoe***Loranthus elegans* Ch. and Sch.,  
*Viscum* sp.Two single records: *Loranthus*, Uniondale, C.P., and *Viscum*, Pretoria District.

**Rust** *Kuehneola Fici* Butl.

Fairly common in Cape, Natal and Transvaal; causes considerable damage at times as a result of defoliation and premature dropping of fruit.

**FINGER GRASS** (*Digitaria ciliartha* Steud.).**Ergot** *Claviceps* sp.

Common in Transvaal and Natal.

**Rusts** *Puccinia Digitariae* Pole Evans,  
*Uromyces Peglerae* Pole Evans.

Common in Transvaal and Natal.

**Smut** *Tolyposporium* sp.

Occurs in Natal and Transvaal.

**Streak** Virus.

In Natal, near cane fields shewing streak; also on *D. horizontalis* Willd., *D. marginata* Link., *D. Smutsii* Stent and *D. ternata* Stapf; mosaic has been observed on *D. horizontalis* and *D. marginata*.

**FLAT CROWN** (*Albizzia fastigiata* Oliv.).**Black Spot** *Phragmocaula virentis* (Cke.) Th.  
and Syd.

Occurs in Natal.

**Mildew** *Microstroma Albizziae* Syd.

Occurs in Natal.

**Rust** *Ravenelia minima* Cke.

Fairly common near the Natal Coast.

**Trunk Rot** *Polyporus capensis*.

Durban, 1917.

**FLORIDA GRASS.** See **BERMUDA GRASS.****FOXGLOVE** (*Digitalis* sp.).**Stem Rot** *Phoma* sp.

Reported from Natal; not common.

**FOX TAIL MILLET.** See **MANNA.****FREESIA** (*Freesia refracta* Klatt.).**Corm Rot** *Fusarium* sp.

A common storage rot.

**Rust** *Uromyces Ecklonii* Bubak,  
*U. Freesiae* Bubak.

Occasional, Cape and Transvaal.



**FRENCH BEAN** (*Phaseolus vulgaris* L. and *Ph. multiflorus* Willd.).

- Bacterial Blight** *Bacterium Phaseoli* Erw. Sm.  
On leaves, stems and pods; is widely distributed but is most prevalent and destructive in the Transvaal.
- Anthracnose** *Colletotrichum lindemuthianum* (Sacc. and Magn.) Br. and Cav.  
On pods, leaves and stems: widely distributed and common. May be very destructive; occurs as an epiphytotic.
- Fusarium Wilt** *Fusarium* sp.  
Known in the Cape and Transvaal, but so far is not important.
- Leaf Blotch** *Cercospora cruenta* Sacc.  
Occurs in the Transvaal, Cape and Natal, but does most damage in Natal.
- Leaf Scorch** *Isariopsis griseola* Sacc.  
Only seen once at Pretoria, unimportant.
- Leaf Scorch** *Phyllosticta phaseolina* Sacc.  
Only known to occur in Pretoria District; not important.
- Leaf Spot** *Macrosporium phaseoli* Fautr.  
Occurs in the Cape.
- Pod Blight** *Phoma subcircinata* Ell. and Ev.  
Known only from Zululand. Not important.
- Root Parasite** *Melasma orobanchoides* Eng.,  
*Melasma* (= *Alectra vogelii* Benth.)  
Observed in Northern Transvaal.
- Root Rot** *Rhizoctonia* sp.  
Reported from Natal and Eastern Cape.
- Rust** *Uromyces appendiculatus* (Pers.) Lk.  
On leaves, pods, and stems; widely distributed and common. Very destructive at times: the severity with which it attacks the crop is often correlated with cultural, as well as with seasonal conditions.
- Yeast Spo** *Nematospora coryli* Pegl.,  
*N. gossypii* Moore.  
Reported from Natal and Rustenburg District, Transvaal.

**GAILLARDIA** (*Gaillardia* sp.).

- Mildew** *Oidium* sp.  
Few definite records, but is probably common.

**GEISSORHIZA, SYSIE** (*Geissorhiza* spp.).

- Rust** *Uromyces Geissorhizae* P. Henn.  
Recorded by Sydow (Monograph Ured. II, p. 253), on *G. rupestris* and *G. secunda* from South Africa; not known otherwise.

**GERANIUM** (*Pelargonium* spp.).

**Dodder** *Cuscuta arvensis* Beyr.

Observed at Klerksdorp, Transvaal; not common.

**Leaf Spot** *Septoria Pelargonii* Syd.

Sometimes occurs in parts of the Cape and Transvaal; not important.

**Rusts** *Puccinia granularis* K. and Cke.,  
*P. Pelargonii-zonalis* Doidge.

Both widespread throughout South Africa; the former on indigenous species of *Pelargonium*; the latter is the common rust of the cultivated Geranium (*Pelargonium zonale* L'Hérit). Destructive at times.

**GERMISTON GRASS.** See **BERMUDA GRASS.****GIFT BOOM** (*Acokanthera venenata* Don. and *A. spectabilis* Hk.).

**Leaf Mould** *Asterinella Acokantherae* Doidge.

Common in forests, Cape and Natal Coast.

**GILIA** (*Gilia rubra* Heil.).

**Fusarium Wilt** *Fusarium* sp.

Occurs in Transvaal; probably not important.

**GLADIOLUS** (*Gladiolus* spp.).

**Corm Rot** *Botrytis cinerea* Auct.

Reported from George, Cape; not common.

**Dry Rot** *Fusarium* sp.

In corms of cultivated plants and of those growing under natural conditions. Transvaal.

**Rusts** *Uromyces Gladioli* P. Henn.,  
*U. transversalis* (Thuem.) Wint.,  
*Puccinia Gladioli-crassifolii* Doidge.

The first two species are common and widely distributed; the last only found once in Transvaal.

**GOLDEN MILLET** (*Setaria aurea* R.Br. and *S. nigrirostris* Dur. and Schinz.).

**Black Spot** *Phyllachora Evansii* Syd.

Common in Transvaal.

**Bulrush Fungus** *Epichloe Zahlbruckneriana* P. Henn.

In Pretoria District, Transvaal.

**Ergot** *Claviceps* sp.

In Pretoria District, Transvaal.

**False Mildew** *Beniowskia sphaeroidea* (K. and Cke.)  
Mason (= *Aegerita Penniseti* P. Henn.)

Reported from Natal.

- Pink Mould** *Fusarium* sp.  
Fairly common in Transvaal.
- Smut** *Ustilago Evansii* P. Henn.  
Common throughout the country.

**GOOSE GRASS** (*Eleusine indica* Gaertn.).

- Smut** Organism undetermined.  
Found in the Transvaal.
- Streak** Virus.  
Natal coast, in proximity to affected cane fields.

**GRANADILLA** (*Passiflora edulis* Sims. and *P. quadrangularis* L.).

- Anthracnose** *Colletotrichum* sp.  
Causes sunken spots on fruit : one record only —from White River, Transvaal.
- Leaf Spot** *Macrosporium* sp.  
Occurs in Transvaal and Cape : Of little importance.
- Leaf Spot. Fruit Spot** *Ascochyta* sp.  
Said to be very destructive at times in coastal districts of Natal.

**GRAPE FRUIT** (*Citrus grandis* Osbeck.).

- Canker** See under **Orange**. *Bacterium citri* Hasse.
- Concentric Ring Blotch** Cause unknown.  
Is often severe on nursery stock. The lesions on the leaves differ considerably in appearance from those on orange and rough lemon.
- Die Back** See under **Orange**. *Colletotrichum gloeosporioides* Penz.,  
*Diplodia natalensis* Pole Evans.
- Tear-staining** *Colletotrichum gloeosporioides* Penz.  
Is found fairly commonly on fruit growing in the more humid areas, e.g., Northern and Eastern Transvaal and near the south-east coast.
- Verrucosis or Scab** (*Sporotrichum citri* Butl.  
(=*Sphaceloma Fawcetti* Jenk.).  
A few records of the occurrence of scab on this host have come from the south-east coast, but it is not common and not usually severe on grape fruit. In the Eastern Transvaal, grape fruit trees are often free from scab in localities where rough lemons are badly affected.

**GRAPE VINE** (*Vitis* spp.).

- Anthracnose** *Gloeosporium ampelophagum* Sacc.  
(=*Sphaceloma Ampelinum* de Bary).  
Common and widespread ; often causes considerable damage, especially in the summer rainfall areas.

**Berry Wilt and Rot***Sphaeropsis Malorum* Pk.

Said to occur in the South-western Cape Province. (Stellenbosch-Elsenburg Sc. Bull. No. 86.).

**Black Rot***Guignardia Bidwellii* Vi. et Rav.

Maritzburg, Natal, 1911. This single occurrence of black rot was dealt with by quarantine measures and no further spread of the disease has been recorded.

**Blister Blight***Exobasidium Vitis* Prill.

Observed only in Pretoria, Transvaal.

**Court Noué**

Non-parasitic.

Reported from Paarl, Cape.

**Crown Gall***Bacterium tumefaciens* Sm. and Town.

Fairly common in Cape and Transvaal. Does not seem to cause serious damage.

**Dead Arm**

Cause unknown.

Common near Somerset West, Cape, in 1923, causing death of vines here and there.

**Downy Mildew***Plasmopora viticola* (B. and C.) Berl. and De Toni.

Occurs sporadically in the summer rainfall areas, but does not become serious under South African conditions.

**Grey Mould***Botrytis cinerea* Pers.

In Cape and Transvaal; not usually of much importance.

**Leaf Blight***Cercospora viticola* Sacc.

Reported from several parts of the Transvaal and from East Griqualand; not important.

**Leaf Blotch***Macrosporium Vitis* Sorok.

Reported from Rustenburg, Transvaal, only; not important.

**Leaf Spot***Phyllosticta* sp.

One record from Cradock, Cape; unimportant.

**Mildew***Oidium Tuckeri* Berk.

Widespread and common; sometimes very destructive in the summer rainfall areas. The perfect stage has not been found.

**Storage Rots***Penicillium* spp., *Aspergillus* spp.

Common in stored fruit.

**GUINEA GRASS** (*Panicum maximum* Jacq.).**Black Spot***Phyllachora heterospora* P. Henn.

Found in Natal, Cape, and Transvaal; causes appreciable leaf injury in Natal.

**Black Spot***Phaedothis stenostoma* (Ell. and Fr.)  
Th. and Syd.

Found in Natal.

<b>Ergot</b>	<i>Claviceps</i> sp.
Cape and Transvaal.	
<b>Pink Mould</b>	<i>Fusarium</i> sp.
Found in Natal, Cape, and Transvaal.	
<b>False Smut</b>	<i>Cerebella Panic</i> Tracy and Earle.
Recorded from North-eastern Cape and Pretoria, Transvaal.	
<b>Rust</b>	<i>Uromyces leptodermus</i> Syd.
On the Natal Coast.	
<b>Smut</b>	<i>Ustilago heterospora</i> P. Henn. and Evans.
Found in Natal and Transvaal.	

#### **GYPSOPHILA** (*Gypsophila* sp.).

<b>Wilt</b>	<i>Fusarium</i> sp. and <i>Rhizoctonia</i> sp.
Both organisms found simultaneously attacking plants in Pretoria, Transvaal.	

#### **GUAVA** (*Psidium guajara* L.).

<b>Anthracnose</b>	<i>Gloeosporium</i> sp.
Only recorded from Nelspruit, Eastern Transvaal.	
<b>Black Rot</b>	<i>Sphaeropsis</i> sp.
Transvaal, locality unknown.	
<b>Chlorosis</b>	Cause unknown.
In the South-western Cape.	

#### **HAREBELL, WINDBELL** (*Dierama pendula* Bkr. and *D. pulcherrima* Bkr.).

<b>Rusts</b>	<i>Uromyces Sparaxidis</i> Syd. <i>Puccinia Dieramae</i> Syd.
Natal, Zululand, and Eastern Cape.	

#### **HARICOT BEAN** (*Phaseolus vulgaris* L.).

<b>Rust</b>	<i>Uromyces appendiculatus</i> (Pers.) Lk.
In the Transvaal.	
<b>Sclerotium Wilt</b>	<i>Sclerotium Rolfsii</i> Sacc.
Reported from Barberton, Transvaal.	

#### **HEMP** (*Cannabis sativa* L.).

<b>Mildew</b>	<i>Oidium</i> sp.
Not uncommon.	

#### **HIBISCUS** (*Hibiscus rosa-sinensis* L.).

<b>Leaf Spot</b>	<i>Phyllosticta idaeicola</i> Cke.
Said to occur at Stellenbosch, Cape.	

**HOLLYHOCK** (*Althaea rosea* Cav.).

- Rust** *Puccinia malvacearum* Mont.  
Common and widely distributed. Destructive under moist conditions.
- Wilt** *Rhizoctonia* sp.  
Only reported from Johannesburg, Transvaal.

**HOPS** (*Humulus Lupulus* L.).

- Mildew** *Oidium* sp.  
On experimental crop, George, Cape.

**HORSE RADISH** (*Cochlearia armoracia* L.).

- White Rust** *Cystopus candidus* (Pers.) De By.  
[= *Albugo candidus* (Pers.) Kuntze.]  
Reported from Stellenbosch, Cape.

**HOUND'S TONGUE** (*Cynoglossum micranthum* Desf.).

- Rust** *Accidium Daryi* Syd.  
Several records from Natal and Transvaal.

**HYDRANGEA** (*Hydrangea opuloides* Koch.).

- Mildew** *Oidium* sp.  
Locality not recorded.

**HUILBOS** (*Peltophorum africanum* Sond.).

- Black Spot** *Phyllachora Peltophori* Syd.  
One record from Northern Transvaal.

**HYACINTH BEAN** (*Dolichos lablab* L.).

- Leaf Spot** *Ascochyta Pisi* Lib.  
Reported only from Natal; occurrence infrequent.

**HYPOXIS** (*Hypoxis* spp.).

- Rust** *Uromyces Hypoxidis* Oke.  
On *H. oligotricha* Bkr., *H. villosa* L.f., and *H. latifolia* Hk., Natal and Transkei.
- Rust** *Puccinia Pole-Evansii* Doidge.  
On *H. acuminata* Bkr., *H. costata* Bkr., *H. rigidula* Bkr., and other *Hypoxis* spp. Natal and Transvaal.

**ICELAND POPPY** (*Papaver nudicaule* L.).

- Crown Rot and Wilt** *Pythium ultimum* Trow.  
Pretoria, Transvaal; associated with this organism, pathogenicity not proved conclusively.

**Wilt***Fusarium* sp., *Rhizoctonia* sp.

Transvaal; may be destructive at times; associated with above organisms, but pathogenicity not yet proved.

**IRIS** (*Iris* spp.).**Leaf Spot***Heterosporium gracile* (Wallr.) Sacc.

Common in Cape and Transvaal; seriously affecting plants in wet seasons.

**IRONWOOD, YSTERHOUT** (*Olea capensis* L. and *O. laurifolia* Lam.).**Black Spot***Perisphiza oleifolia* (K. and Cke.) Syd.

Found in Cape and Transvaal.

**Leaf Moulds***Asterodithis solaris* (K. and Cke.) Th.*Meliola oleicola* Doidge,*Meliola petiolaris* Doidge.

*A. solaris* is extremely common on leaves of ironwood trees; the two species of *Meliola* are less frequent.

**Trunk Rots***Fomes rimosus* Berk., *F. australis* Fr.,*F. applanatus* Wallr.

In the forests of Zululand and the Eastern Cape.

**ITALIAN RYE GRASS** (*Lolium italicum* A.Br.).**Rust***Puccinia coronata* Corda.

Found in Natal.

**IXIA** (*Ixia maculata* L.).**Rust***Uromyces Zeyheri* Bubak

South-western Cape. Sydow in his monograph (Mon. Ured. II, p records the occurrence of *Uromyces Ixiae* (Lev.) Wint., on a n of species of *Ixia*.

**JAK FRUIT** (*Artocarpus integrifolia* L.f.).**Fruit Rot***Rhizopus* sp.

One record from Northern Transvaal).

**JOHNSON GRASS** (*Sorghum halepensis* Stapf).**Anthraxnose***Colletotrichum* sp.

Found in Pretoria District, Transvaal.

non

**Downy Mildew***Sclerospora graminicola* (Sacc.)

Occurs in Pretoria District, Transvaal.

**Leaf Blight***Helminthosporium* sp.

c in

Recorded from Ccdara, Natal.

**Rust***Puccinia purpurea* Cke.

Common on the coast from Portuguese East Africa to Natal.

iz.

**Smut***Sorosporium Simii* Pole Eva

Found in Natal.

**KAFFIR BEAN.** See **COW PEA.**

**KAFFIR CORN** (*Sorghum vulgare* L.).

**Downy Mildew** *Sclerospora graminicola* Schroet.  
Occurs in Zululand; not important.

**Pink Mould** *Fusarium* sp.  
In Natal; not important.

**Rust** *Puccinia purpurea* Cke.  
Occurs in Natal.

**Smut** *Sphacelotheca sorghi* (Link.) Clint,  
I [= *Cintractia sorghi vulgaris*  
(Tul.) Clint].

Common in the Transvaal, Natal and Eastern Cape.

**Witchweed, Rooibloom** *Striga lutea* Lour.

Prevalent in Natal and Western and Northern Transvaal; said to be spreading and becoming a serious pest.

**KAFFIR GROUND BEAN** (*Voandzeia subterranea* Thouars).

**Mildew** *Erysiphe Polygoni* D.C.  
H Natal and Swaziland.

**ALF** (*Brassica oleracea* L. var. *acephala*).

**er and Toe, Club Foot** *Plasmodiophora Brassicae* Wor.

**HUI**id to occur at Wellington, Cape.

**Bl**  
(**SSI** (*Gonioma Kamassi* E. Mey.).

**Mould** *Meliola Goniomac* Doidge.

**HYA** Cape Forests, Van Stadens Pass to George.

**Lea**  
**ELDORING.** See **CAMEL THORN.**

**HYPOOORN.** See **WILD ASPARAGUS.**

**Rus**  
**O PLE** (*Doryalis caffra* Hk. and Harv.).

**Spot** *Phyllachora Aberiae* P. Henn

**Rust**orted from Eastern Cape and Northern Transvaal.

**Or**  
**UT.** See **CHERRYWOOD.**

**ICELAI** (*Pterocarpus angolensis* D.C.).

**Crowipot** *Catacauma Pterocarpis* Syd.  
Pred in the Transvaal.  
pic



**KIKUYU GRASS** (*Pennisetum clandestinum* Chiov.).**Leaf Blight***Helminthosporium* sp.

Reported from Mooi River, Natal.

**KLIMOP.** See **WILD CLEMATIS.****KLIP ELS** (*Plectronia Mundtiana* Pappe.).**Leaf Mould***Meliola woodiana* Sacc.Natal; also occurs on *P. ventosa*, and other *Plectronia* spp. in Natal, Eastern Cape, George and Knysna.**KNOBWOOD, PERDEPRAM** (*Fagara* spp.).**Leaf Mould***Meliola Toddaliae* Doidge.Fairly common in the forests on *F. capensis* Thuem. and *F. Davyi* Verdoorn.**Rust***Puccinia Fagarac* Doidge.In the Pirie Forest, Kingwilliamstown District on *F. Davyi*.**KOFFIE PEER.** See **COFFEE PEAR.****KWEEK GRAS.** See **BERMUDA GRASS.****LACHENALIA** (*Lachenalia* sp.).**Rust***Uromyces Lachenaliae* Doidge.

Cape Province.

**LARGE SEEDED PANIC** (*Brachiaria brizantha* Stapf).**Ergot***Claviceps* sp..

Occurs in Cape and Transvaal.

**False Smut***Cerebella Panici* Tracy and Earle

Occurs in the Transvaal.

**LARKSPUR** (*Delphinium* sp.).**Fusarium Wilt***Fusarium* sp.

Reported from one or two localities in the Transvaal, but probably common throughout this Province.

**Mildew***Erysiphe Polygoni* D.C.

Common in Transvaal and the coast districts of Natal. Destructive in wet seasons.

**LEMON** (*Citrus limonis* Osbeck).**Anthraxnose***Colletotrichum gloeosporioides* Penz.

Wound parasite of fruit. Common.

**Bacterial Spot***Bacillus citrimaculans* Doidge.

In the winter rainfall area only; may be destructive in wet seasons.

**Black Rot** *Diplodia natalensis* Pole Evans.

Occasionally found on fruit, leaves and twigs.

**Canker** See under **Orange**. *Bacterium citri* Hasse.

**Chlorosis** See under **Orange**. Non-parasitic.

**Concentric Ring Blotch** Cause unknown.

Extremely common on rough lemon stocks, but never yet observed on the more common budded varieties, e.g. Eureka, Villa Franca. One severe outbreak is on record on the variety locally known as the "Spanish" lemon. Largely a disease of nursery stock and young trees.

**Dry Root Rot.** See also under **Orange**.

Most of the citrus trees in South Africa are grown on "rough" lemon stocks, and the roots of these are frequently attacked.

**Internal Break Down** Non-parasitic.

Common, especially on fruit which has been left too long on the trees.

**Leaf Spot** *Alternaria Citri* Pierce.

This brown spot is common on leaves of rough lemon stocks, often causing partial or complete defoliation. It is most severe in the "mist belt" of Natal and Eastern Transvaal, in almost all localities where seab is found, but also occurs to some extent in all citrus-growing areas.

**Moulds** *Penicillium digitatum* Sacc.,  
*P. italicum* Wehm.

Common fruit-rotting organisms.

**Oleocellosis** See under **Orange**. Non-parasitic.

In the winter rainfall area these spots show a dark brown discolouration, owing to the invasion of the oleocellosis spots by a *Phoma* sp.

**Scab or Verrucosis** *Sporotrichum Citri* Butl.,  
(=*Sphaeceloma Fawcetti* Jenk).

Exceedingly common in the humid areas known as the "mist belt," severely attacking the rough lemon and being also found on the budded varieties. Most troublesome near the south-east coast and in the Northern and Eastern Transvaal.

**Styler End Rot** *Alternaria citri* Pierce.

In one locality in the Clanwilliam District, this fungus attacked ripening lemons on the trees.

## **LETTUCE** (*Lactuca* sp.).

**Grey Mould** *Botrytis cinerea* Pers.

Found on plants in vegetable market, Capetown.

**Rhizoctonia Wilt** *Rhizoctonia* sp.

Found occurring in conjunction with *Tylenchus Nemas*, and is therefore possibly of secondary importance. Pretoria, Transvaal.

## **LIMA BEAN** (*Phaseolus lunatus* L.).

**Leaf Spot** *Ascochyta Pisi* Lib.

Known only from Cedara, Natal.

**LITCHI** (*Litchi chinensis* Sonn.).

**Stem Rot** ? *Nummularia* sp.

Only known at Verulam, Natal: the fungus was possibly secondary.

**LOGANBERRY** (*Rubus loganobaccus* Bailey).

**Crown Gall** *Bacterium tumefaciens* Sm. and Towns.

Common in the South-western Cape.

**LOQUAT** (*Eriobotrya japonica* Lindl.).

**Leaf Blotch** *Fabraea maculata* (Lev.) Atk.

( *Entomosporium maculatum* Lev.).

Fairly common, both in Western Cape and Transvaal. Not important.

**Scab** *Fusicladium Eriobotryae* Cav.

Common in the South-western Cape.

**LOVE GRASS** (*Eragrostis* spp.).

**Downy Mildew** *Sclerospora* ? *graminicola* (Sacc.)  
Schroet.

Reported from Pinetown, Natal.

**Mosaic** Virus.

Natal coast. One species of *Eragrostis* has been found shewing Mosaic.

**Rust** *Uromyces Eragrostidis* Tracey.

Common in the Transvaal.

**Streak** Virus.

Natal coast. Streak has been found on four species of *Eragrostis*.

**LUCERNE** (*Medicago sativa* L.).

**Anthracnose** *Colletotrichum Trifolii* Bam.

Reported from Uitenhage, Cape, and Pretoria and Potchefstroom, Transvaal. Destructive at times.

**Crown Rot** *Fusarium* sp.

Fairly common in Transvaal; suspected of causing considerable damage under conditions suitable for its development.

**Downy Mildew** *Peronospora trifoliorum* De By.

Known to occur in Transvaal, Orange Free State and Natal. Not serious.

**Leaf Spot** *Pseudopeziza Medicaginis* (Lib.) Sacc.

Common and widespread; not usually destructive.

**Grey Mould** *Diachea leucopoda* (Bull.) Rostr.

*Physarum cinereum* (Batsch.) Pers.

Caused considerable damage one year at Pyramids, Transvaal.

**Rhizoctonia Wilt** *Rhizoctonia crocorum* (Pers.) D.C.

Occurs in parts of Natal and Transvaal; not serious.

**Rust** *Uromyces striatus* Schroet.

Common and widespread; often destructive in wet seasons.

**Stem Spot** *Phoma* sp.

Reported from White River, Transvaal. Not important.

**Stem Spot** *Pleospora vulgarissima* Speg.

Two isolated records from Cape and Northern Transvaal. Not important.

## **LUPIN** (*Lupinus* sp.).

**Fusarium Wilt** *Fusarium* sp.

Reported as being very destructive in this crop at Cedara, Natal.

## **MAIZE** (*Zea Mays* L.).

**Boil Smut** *Ustilago Zeae* (Beck.) Unger.

Occurs sporadically throughout the country, but rarely causes appreciable loss.

**Brown Rust** *Puccinia Maydis* Bereng.

Universally prevalent, but usually develops late in the season so that the damage is comparatively slight. The accidial stage on *Oxalis corniculata* is rarely found.

**Downy Mildew** *Sclerospora Maydis* (Rac.) Bull.

Occurs on the Natal coast and inland as far as Pinetown; also found to a slight extent in the Transvaal. Usually unimportant.

**Dry Rot, Ear Rot** *Diplodia Zeae* (Schw.) Lév.

Common and widespread; has caused a high percentage of loss some seasons in the Transvaal and Northern Natal.

**Leaf Blight** *Helminthosporium turcicum* Pass.

Causes considerable damage in Natal in wet seasons, but elsewhere ill effects appear to be slight.

**Leaf Mould** *Cladosporium Zeae* Pk.

Common in Natal and Transvaal in wet seasons, but of little importance.

**Leaf Spot** *Macrosporium Maydis* C. and E.

Not common; only reported from Kingwilliamstown, Cape.

**Pinking** Non-parasitic.

An inherited colouration of the grains which occurs commonly.

**Streak** Virus.

Causes a considerable amount of damage to the maize crop, particularly to late sowings. It is essentially a disease of low and middle-valley areas; being found only rarely above 4,000 feet altitude. Most common in Natal and Zululand, but also reported from Cape and Transvaal. Transferred by the leaf-hopper, *Balclutha mbila* Naude.

**Root-, Stalk- and Ear-Rot** *Fusarium moniliforme* Sheld.,  
[=*Gibberella saubinetii* (Mont.),  
Sacc.].

Very common and widespread, causes considerable damage to the crop by rotting the ears and by stunting and wilting the plants. Other organisms may also be involved.

**Tassel Smut, Head Smut** *Sorosporium reilianum* (Kühn) Weber.  
More common and widespread than the "Boil Smut"; does not cause serious damage in normal seasons.

**Variegation** Non-parasitic.  
A fairly common, inherited leaf variegation; not important.

**Witchweed, Rooibloom** *Striga lutea* Lour.  
Widely distributed; a limiting factor in the growth of maize in many areas.

## **MANGEL, MANGEL-WURZEL, MANGOLD** (*Beta vulgaris* L. var. *macrocarpa*)

**Heart Rot, Dry Rot** *Phoma Betae* (Oud.) Frank.  
Said to occur at Stellenbosch, Cape.

**Leaf Blight** *Cercospora albo-maculans*  
(Ell. and Ev.) Sacc.  
Only recorded from Johannesburg, Transvaal; not important.

**Leaf Spot** *Cercospora beticola* Sacc.  
Fairly common in South-western Cape and in Natal; not usually destructive.

**Root Rot** *Rhizoctonia* sp.  
Fairly common in Natal; caused entire loss of this crop in many localities—near Estcourt in 1923; probably more widely distributed than is known.

**Rust** *Uromyces Betae* (Pers.) Kühn.  
Occurs wherever the crop is grown; serious in wet seasons.

**Scab** *Actinomyces* sp.  
Said to occur at Stellenbosch, Cape.

## **MANGO** (*Mangifera indica* L.).

**Anthracnose, Ripe Rot** *Colletotrichum gloeosporioides* Penz.  
Fairly common in Northern and Eastern Transvaal and in Natal; also occurs in Swaziland and in Portuguese East Africa. Causes considerable damage.

**Bacterial Spot** *Bacillus Mangiferae* Doidge.  
Common in Northern and Eastern Transvaal and Natal; very destructive in wet seasons.

**Mildew** *Oidium* sp.  
Reported from Nelspruit, Transvaal, and Umbilo, Natal, as destroying the inflorescence. Not common.

## **MANNA** (*Setaria italica* Beauv.).

**Smut** *Ustilago Crameri* Korn.  
Found at Standerton, Transvaal and Fort Louis, Zululand.

**MARROW, SQUASH** (*Cucurbita pepo* L.).

**Mildew** *Erysiphe cichoracearum* D.C.

Very common and widespread; destructive in wet seasons.

**Mosaic** Virus.

Fairly common, and sometimes becomes severe towards the end of the season.

**MELON** (*Cucumis Melo* L.).

**Mildew** *Erysiphe cichoracearum* D.C.

Very prevalent and destructive in wet seasons.

**MEROOLA** (*Sclerocarya caffra* Sond.).

**Anthraxnose** *Gloeosporium Sclerocaryae* Pole Evans

Northern Transvaal; common on fruit.

**MESEMBRYANTHEMUM** (*Mesembryanthemum* sp.).

**Leaf and Flower Blight** *Peronospora Mesembryanthemi* Verw.

Causes an appreciable amount of damage to plants in cultivation; reported from Eastern and South-western Cape.

**Rust** *Puccinia Mesembryanthemi* MacOwan.

Cape and Transvaal; not very common.

**MEXICAN MARIGOLD** (*Tagetes minuta* L.).

**Dodder** *Cuscuta arvensis* Beyr.

Known to occur at Pretoria, Transvaal.

**MICHAELMAS DAISY** (*Aster* sp.).

**Mildew** *Erysiphe Polygoni* D.C.

Common in South-western Cape, Natal, and Transvaal; not of much importance.

**MONTBRETIA** (*Tritonia* spp.).

**Rust** *Uromyces transversalis* (Thum.)

Wint., *U. bonae-spei* Bubak.

Natal and Cape; not very common.

**MULBERRY** (*Morus* spp.).

**Blight** *Bacterium Mori* Boy. and Lamb.

Occurs in Transvaal, Natal, and Cape; often destructive in wet seasons; severe on *Morus nigra* L.

**Leaf Spot** *Septogloeum Mori* Br. & Cav.

Very common in the Transvaal. Occurs to a smaller extent in Cape and Orange Free State.

**MUNG BEAN** (*Phaseolus aureus* Roxb.).

- Anthracnose** *Colletotrichum lindemuthianum* (Sacc. and Magn.) Br. and Cav.  
On stems : reported from Eastern Transvaal only ; not important.
- Bacterial Blight** *Bacterium Phaseoli* Erw. Sm.  
On stems, leaves, and pods : reported from Celara, Natal, and Kaapsche Hoop, Transvaal ; not common.
- Pod Blight** *Phoma subcircinata* Ell. and Ev.  
On leaves, stems, and pods : reported only from Kaapsche Hoop, Transvaal.
- Leaf Spot** *Ascochyta Pisi* Lib.  
So far as is known this disease is confined to Natal, where it is very destructive at times.
- Leaf Scorch** *Phyllosticta* sp.  
Reported from Natal only.

**MUSK MELON** (*Cucumis Melo* L.).

- Downy Mildew** *Peroomycespora cubensis* (B. and C.) Clint.  
Eastern Transvaal ; not common.
- Leaf Spot** *Macrosporium cucumerinum* E. and Z.  
One occurrence at Kraaifontein, Cape ; not important.

**NAARTJE** (*Citrus nobilis* Lour.).

- Anthracnose** *Colletotrichum gloeosporioides* Penz.  
A common wound parasite of the fruit.
- Bacterial Spot** *Bacillus citrimaculans* Doidge.  
Occurs only in the winter rainfall area. Destructive in exceptionally wet seasons.
- Black Rot** *Diplodia natalensis* Pole Evans.  
Only important in the coastal districts of Natal in seasons when late rains have been prolonged into the packing season. Said to have caused severe loss in export fruit on one occasion.
- Concentric Ring Blotch** Cause unknown.  
Less severe on naartje than on orange.
- Corky Scab** Cause unknown.  
Small raised corky growths on the rind of the fruit, occasionally observed on naartjes from Natal and Zululand.
- Exanthema** See also under **Orange**. Non-parasitic.  
Willowmore District, Cape.
- Sooty Mould** *Capnodium citricolum* McAlp.  
Following the attacks of insects. Common in neglected orchards.

**Velvet Blight** *Septobasidium bogoriense* Pat.

Severe infestation reported near East London, Cape.

**Withertip** *Colletotrichum gloeosporioides* Penz.

Appears to be more actively parasitic on naartje trees than on other varieties of citrus; found wilting young shoots in Eastern Transvaal.

**NAPIER FODDER** (*Pennisetum purpureum* Schum. and Thom.).

**False Mildew** *Beniowskia sphaeroidea* (K. and Cke.)

Mason (= *Aegerita Penniseti* P. Henn.).

One record from the Transvaal; also found in Rhodesia.

**NARCISSUS** (*Narcissus* sp.).

**Bulb Rot** *Fusarium* sp.

Occurs in the South-western Cape; not common.

**NASTURTIUM** (*Tropaeolum majus* L.).

**Mildew** *Leveillula taurica* (Lév.) Arn.

(= *Oidiopsis taurica* Lév.).

Common wherever the plant is grown under conditions of excessive shade or moisture.

**NATAL BUFFEL GRASS** (*Setaria sulcata* Raddi.).

**Black Spot** *Phyllachora Evansii* Syd.

Common in Natal and Transvaal.

**NATAL MAHOGANY, ROOI ESSENHOUT** (*Trichilia emetica* Vahl.).

**Black Spot** *Cocconia concentrica* Syd.

Only recorded from Portuguese East Africa.

**Leaf Mould** *Meliola sinuosa* Doidge.

Northern Transvaal.

**NATAL LEAF TOP** (*Tricholaena rosea* Nees.).

**Black Spot** *Phyllachora Tricholaenae* P. Henn.

Natal and Transvaal.

**Rust** *Diorchidium Tricholaenae* Syd.

Natal and Transvaal.

**Smut** *Sorosporium* sp.

Found on the Natal Coast.

**NECTARINE** (*Prunus persica* Sieb. and Zucc. var. *nucipersica* Schneid.).

**Crown Gall** *Bacterium tumefaciens* Sm. and Towns.

Common and widespread.



**Freckle** *Cladosporium carpophilum* Thüm.

Occurs in the fruit-growing areas of Cape and Transvaal but not very common.

**Leaf Curl** *Taphrina deformans* (Berk.) Tul.  
(*Erouscus deformans* Fuck).

Often prevalent in wet seasons on fruit and leaves in Cape and Transvaal orchards.

**Rust** *Puccinia pruni-spinosae* Pers.

Occurs in the South-western Cape, but apparently not very prevalent.

**NEMESIA** (*Nemesia* sp.) *Cystopus Evansii* (Syd) Wakef.

**White Rust**

Orange Free State and Cape ; not frequent.

**NEW ZEALAND SPINACH** (*Tetragonia expansa* Murr.).

**Rust** *Puccinia Tetragoniae* McAlp.

Said to occur at Stellenbosch, Cape.

**OAK** (*Quercus* spp.).

**Mildew** *Microstroma album* (Desm.) Sacc.,  
(= *Oidium quercinum* Thuem.).

Common and widespread ; the perfect stage of the *Oidium* has not been found.

**Minor Troubles**

*Botryodiplodia* sp., *Calospora aurasiaca* (Fahr.) Sacc., *Coryneum disciforme* Kze. and Sch., *Epicoccum* sp., *Pestalotzia* sp., *Polystictus sanguineus* (L.) Fr., *Stereum hirsutum* (Willd.) Fr., *Ustilina vulgaris* Tul.

Fungi reported from various localities but apparently not causing serious damage. Some are probably saprophytes.

**Mistletoe** *Loranthus oleifolius* Ch. and Schl.

Northern Transvaal, spreading from indigenous Acacias.

**OATS** (*Avena sativa* L.).

**Black Rust** *Puccinia graminis* Pers.

Prevalent in all areas where cereals are grown. A limiting factor to cultivation in Natal and elsewhere.

**Covered Smut** *Ustilago levis* (K. and S.) Magn.

Widespread, but extent of damage unknown ; may cause 40 to 60 per cent. loss in the crop.

**Crown Rust** *Puccinia coronata* Cda.

Reported from Cedara, Natal, and several areas in the Transvaal.

**Foot Rot** Cause unknown.

Reported from Potchefstroom, Transvaal.

**Leaf Blotch** *Septoria* sp.

Said to occur in South-western Cape.

**Leaf Mould** *Cladosporium herbarum* (P.) Lk.

Occurred at Maritzburg, Natal.

**Loose Smut** *Ustilago Arvenae* (Pers.) Jens.

Prevalent wherever cereals are grown.

## **OKRA** (*Hibiscus esculentus* L.).

**Mildew** *Oidium* sp.

One record from Pretoria, Transvaal.

## **OLD LANDS GRASS.** See **SWEET GRASS.**

## **OLEANDER** (*Nerium Oleander* L.).

**Bacterial Knot** ? *Bacterium Oleae* (Arcang.) Trev.

Reported from Transvaal and South-western Cape.

## **ONION** (*Allium cepa* L.).

**Black Mould** *Aspergillus niger* Van Tiegh.  
(= *Sterigmatocystis nigra* v. Tiegh.

Reported from South-western Cape.

**Black Spot** *Myrothecium Alliorum* Berk.

One record from Muden, Natal.

**Bulb Rot** *Sclerotinia* sp.

Said to occur in the Cape : no details available.

**Centric Ring Disease** *Colletotrichum circinans* (Berk.) Vogl.

Reported from Grootfontein, Cape ; not important.

**Downy Mildew** *Peronospora Schleideni* Ung.

Common in South-western Cape and Transvaal ; occasionally causes loss in wet seasons.

**Fusarium Wilt** *Fusarium* sp.

Reported once from the Orange Free State.

**Mould** *Macrosporium cladosporioides* Desm.

Only known from Aliwal North, Cape ; not important.

**Neck Rot, Bulb Rot** *Botrytis allii* Munn.

Reported from Molteno, Cape, and Mara, Transvaal ; probably more widespread than is known.

**Pink Root** Cause unknown.

Associated with *Fusarium* spp. ; South-western Cape.

**ORANGE** (*Citrus sinensis* Osbeck.).**Anthraxnose***Colltotrichum gloeosporioides* Penz.

Common on fruit as a wound parasite; often penetrates the rind through punctures made by fruit fly or false codling moth.

**Aspergillus Rot***Aspergillus niger* van Tiegh.

Develops occasionally in storage.

**Bacterial Spot***Bacillus citrimaculans* Doidge.

Occurs only in the winter rainfall area of the South-western Cape; it is only troublesome in exceptionally wet seasons.

**Bark Canker***Amesabadia cravipans* (M. and B.)  
Sacc.

Only recorded once on the bark of an old seedling tree at Krantzklouf, Natal.

**Black Rot***Diplodia natalensis* Pole Evans.

Occurs chiefly near the coast, and is only troublesome in wet years when the rainy season is prolonged into the autumn.

**Black Spot***Phoma citricarpa* McAlp.

Recorded from only one orchard in the Chase Valley, near Maritzburg, Natal.

**Blue Mould***Penicillium italicum* Wehm.

Occurs commonly, especially in storage.

**Brown Rot***Phythocystis citrophthora* R. and E. Sm.

First recorded from Northern Transvaal and the Marico District during the wet summer, 1924-25; is only likely to be troublesome in wet seasons when the rains are prolonged into the autumn.

**Brown Spot**

Non-parasitic.

Develops after picking, and is most severe on smooth-skinned types of oranges; reported during 1929 and 1930, from Transvaal pack-houses.

**Canker***Bacterium citri* Hasse.

Appeared in epidemic form in the Rustenburg, Waterberg, and Pretoria districts of the Transvaal during the years 1909 and 1918. All infected trees and blocks of trees were destroyed, 1918-21, and it may be said that the disease is now non-existent in the Union.

**Chlorosis**

Non-parasitic.

Occurs occasionally and is apparently a nutritional or physiological condition which is imperfectly understood. Folioecellosis is a partial chlorosis, and yellowing and dropping of the leaves is a common occurrence on trees affected by dry root rot.

**Concentric Ring Blotch**

Cause unknown.

Common throughout the Transvaal and parts of Natal and extending through Rhodesia as far as Kenya; not recorded outside Africa. Chiefly a disease of nursery stock and young trees. Fruit may be severely blemished on trees which are just coming into bearing.

- Die-back** *Colletotrichum gloeosporioides* Penz.  
Common throughout the Union on twigs of trees which are weak through other causes; especially common on trees suffering from dry root rot.
- Dodder** *Cuscuta cassythoides* Nees.  
Has been known to invade citrus nurseries in Natal from adjacent indigenous bush.
- Dry Root Rot** Cause obscure.  
Associated with *Fusarium* spp. A common and serious disease throughout the country; most frequent in Transvaal, especially in old seedling trees. Aggravating conditions are excessive moisture, lack of aeration, root injuries, heavy fumigation with cyanide, etc.
- Exanthema** Cause unknown.  
Affects the fruit, leaves and twigs. Has been found in Eastern Transvaal and Albany, Fort Beaufort, and Willowmore districts of the Cape; it may be more common than this indicates.
- Foliocellosis or Mottle-leaf** Non-parasitic.  
Fairly common, especially on neglected trees; said to be a nutritional effect, related in some way to the inability of the tree to satisfy its calcium requirements.
- Green Mould** *Penicillium digitatum* Sacc.  
The most common rot of stored fruit and of fallen oranges in the orchard.
- Leprosis or Nail Head Rust** *Cladosporium herbarum* Lk. var. *citricolum*.  
Has been recorded once from an orchard in the Eastern Cape.
- Melanose** *Phomopsis citri* Fawcett.  
Is found fairly commonly on fruit grown near the south-east coast, especially in Natal.
- Mistletoe, Vuurhoutje** *Loranthus oleifolius* Ch. and Schl. and *L. Dregei* E. and Z.  
Common in the Transvaal and parts of the Cape, especially on old and neglected trees.
- Navel End Rot** *Alternaria Citri* Pierce.  
Fairly common on navel oranges, especially in the Kat River Valley and other areas near the coast; also occurs in Transvaal. Causes considerable loss at times.
- Oleocellosis** Non-parasitic.  
Spots caused by the liberation of oil on the rind are common in the orchard; such spots may always be found and sometimes cause serious blemishes. Fruit shewing oleocellosis spots may, under certain conditions, break down in transit. A brown discolouration in such spots is due to a superficial growth of *Colletotrichum gloeosporioides*.
- Pink Mould** *Cephalothecium roseum* (Fr.). Cda.  
Frequently found as a secondary cause of decay in oranges attacked by *Alternaria* and *Penicillium* spp.

**Psorosis or Scaly Bark**

Cause unknown.

Only attacks trees which are 5 years old or older; a small percentage of trees found affected in many of the older orchards. This is a notifiable disease and infected trees must be destroyed.

**Sooty Blotch and Fly Speck***Leptothyrium Pomi* (Mont. and Fr.), Sacc.

During wet seasons causes serious blemishing of the fruit in the Northern and Eastern Transvaal; only develops under very humid conditions.

**Sooty Mould***Capnodium citricolum* McAlp.

On trees infested with scale, psylla and other insects; common in neglected orchards.

**Sour Rot***Oospora citri-aurantii* Ferrar.

Not common, and often associated with the brown rot caused by *Pythia-cystis citrophthora*; only recorded from Northern Transvaal.

**Stem End Rot, Centre Rot***Alternaria citri* Pierce *A. tenuis* Nees.

A common storage rot, developing on fruit which has been held too long on the trees or in storage.

**Stem End Rot***Phomopsis citri* Fawcett.

Has only been reported from Rustenburg, Transvaal, but may occur fairly commonly.

**Tear Staining***Colletotrichum gloeosporioides* Penz.

A superficial staining occurring under humid conditions in Eastern Transvaal and near the south-east coast.

**Twig Blight***Diplodia natalensis* Pole Evans.

Often found on twigs of trees which are weakened through other causes. Usually found near the coast.

**Velvet Blight***Septobasidium bogoriense* Pat.

Occasionally found on twigs and small branches in the more humid districts. Has been reported from the south-east coast and from Northern and Eastern Transvaal. Severe infestation reported from orchards at Kidd's Beach and Xmas Vale near East London.

**Verrucosis or Scab***Sporotrichum Citri* Butt.  
(=*Sphaceloma Fawcetti* Jenk).

Occurs rarely on the sweet orange and then only in very humid localities where the orchards are close to indigenous bush.

**PALM** (*Phoenix* sp.), etc. P.**Anthraxnose***Colletotrichum* sp.

Said to occur in South-western Cape.

**False Smut***Graphiola Phoenixis* Poit.

Common on *Phoenix reclinata*; often causes considerable damage.

**Leaf Mould***Ecosporium palmivorum* Sacc.

Reported from Durban, Natal.

**Leaf Mould***Meliola palmicola* Wint.

Near the coast in Natal and Eastern Cape, on *Phoenix reclinata*.

**PARSLEY** (*Petroselinum hortense* Hoffm.).

**Leaf Spot** *Septoria Petroselini* Desm.  
South-western Cape and Maritzburg, Natal.

**PARSNIP** (*Pastinaca sativa* L.).

**Early Blight** *Cercospora Apii* Fres. var. *Pastinacae* Sacc.  
Only known to occur at Cedara, Natal.

**PASPALUM** (*Paspalum* sp.).

**Ergot** *Claviceps Paspali* Stev. and Hall.  
Widely distributed throughout South Africa; severe infestations occur in the more humid areas.

**PAWPAW** (*Carica papaya* L.).

**Black Spot** *Macrosporium* sp.  
Common; usually associated with the ripe rot fungus to which it is secondary.

**Foot Rot** *Pythium ultimum* Trow., *Pythium aphanidermatum* (Eds.) Fitz.  
Occurs commonly in Eastern and Northern Transvaal and has been recorded from Cape and Natal. The fungi are weak parasites, and the appearance of the disease usually indicates unfavourable soil or climatic conditions. Certain *Fusarium* spp. are also often present in affected tissues.

**Leaf and Fruit Spot** *Phoma* sp.  
Only recorded from Pietersburg District, Transvaal.

**Mildew** *Oculariopsis Papayae* v. d. Byl.  
Occurs near the Natal coast; sometimes causes defoliation.

**Petiole Anthracnose** *Colletotrichum* sp.  
Very prevalent; important as a possible source of infection of the fruit.

**Ripe Rot, Anthracnose** *Gloeosporium Papayae* P. Henn.  
Occurs commonly wherever pawpaws are grown, often causing serious breakdown of the fruit.

**Stem Rot, Stem Anthracnose** *Gloeosporium Papayae* P. Henn.  
Reported from East London and Trapp's Valley, Cape, and from Rustenburg and Nelspruit, Transvaal.

**White Fruit Spot** Non-parasitic.  
Fairly common as a disfiguring blemish in the Transvaal; is probably the result of some slight mechanical injury.

**PEA** (*Pisum sativum* L.).

**Bacterial Blight** Organism not determined.  
Destroyed entire crop at East London in 1928.

**Downy Mildew** *Peronospora Viciae* Berk.

Only known from Ceres, Cape.

**Fusarium Wilt** *Fusarium* sp.

Only recorded from East London, Cape.

**Leaf Blight** *Septoria Pisi* West.

Said to occur in South-western Cape; not important.

**Leaf Spot** *Ascochyta Pisi* Lib.

Occurs fairly commonly in South-western Cape; also found at Kentani, Cape, and Pretoria, Transvaal. Not usually important, but may be destructive when conditions favour its development.

**Mildew** *Erysiphe Polygoni* D.C.

Common and widespread, but not usually destructive.

**Mosaic** Virus.

Affects leaves and pods; observed in the Pretoria District.

## **PEACH** (*Prunus persica* Sieb. and Zucc.).

**Brown Rot** *Sclerotinia fructigena* (Pers.) Schroet.

Rare; only found at Pretoria, Transvaal in exceptionally wet seasons.

**Chlorosis** Non-parasitic.

Common in Cape and Transvaal orchards.

**Crown Gall** *Bacterium tumefaciens* Sm. and Towns.

Extremely common and widespread on peach stocks; very destructive in some localities.

**Die Back** *Cytospora leucostoma* (Pers.) Sacc.

In localities in Orange Free State and Transvaal; usually on neglected trees.

**False Silver Leaf** Non-parasitic.

A silvering of the leaves often observed late in the summer; cause unknown.

**Freckle** *Cladosporium carpophilum* Thuem.

Very prevalent, especially in the Transvaal, where it causes considerable loss by disfiguring and dwarfing the fruit.

**Leaf Curl** *Taphrina deformans* (Eckl.) Tvl.

Widespread and common; becomes destructive when there are prolonged rains in the spring.

**Mildew** *Sphaerotheca panosa* Lév. var. *Persicæ*.

Reported from Simondium, Cape and from Natal; may be rather troublesome in the nursery.

**Mould** *Rhizopus nigricans* Ehb.

A very common cause of decay in ripe fruit.

**Rust** *Puccinia Pruni-spinosae* Pers.  
[=*Tranzschelia punctata* (Pers.)  
Arth.].

Very prevalent and widespread, often causing premature defoliation in the late summer. The aecidial stage is unknown in South Africa.

**Silver Leaf** *Stereum purpureum* Fr.

Occurs in South-western Cape, but is not serious.

**Velvet Blight** *Septobasidium* sp.

Reported from Barberton, Transvaal.

## **PEANUT, GROUND NUT** (*Arachis hypogaea* L.).

**Bacterial Wilt** *Bacterium solanacearum* Ew. Sm.

Restricted to the Natal coast; not important.

**Leaf Spot** *Cercospora personata* (B. and C.) Ell.  
(=*Septoglocum Arachidis* Rac.).

Fairly common in all peanut-growing areas, but not usually destructive.

**Root Parasite** *Melasma (Alectra vogelii* Benth.),  
*M. sessiliflorum* Benth.

The first species occurs occasionally on peanuts in Northern Transvaal; *M. sessiliflorum* in Natal. Not important.

**Root Rot** *Rhizoctonia* sp.

Occurs to some extent in peanut crops in Transvaal.

**Rosette** Virus.

Observed in the Transvaal and on the Natal coast. Causes serious loss some seasons in Northern Transvaal, but elsewhere it is less severe. Transferred by *Aphis leguminosae* Theo.

**Sclerotium Wilt** *Sclerotium Rolfsii* Sacc.

Common in the Transvaal; not important.

## **PEAR** (*Pyrus communis* L.).

**Bitter Rot** *Glomerella cinquilata* (Stonem.)  
Sp. and v. Schr.

Only observed at Pretoria, Transvaal.

**Black End of Fruit** Non-parasitic.

Reported from Ceres and Stellenbosch, Cape, and also occurs in the neighbourhood of Johannesburg, Transvaal. Attributed to grafting on Japanese stocks.

**Blossom Blight** *Bacterium nectarophilum* Doidge.

In orchards in the South-western Cape.

**Canker** *Nectria galligena* Bres.

Only one record from Kimberley, Cape.

**Chlorosis** Non-parasitic.

Reported from Graaff-Reinet, Douglas and Bonnievale, Cape.



**Cracking and Branch Blister** *Coniothecium chomatosporum* Cda.  
Common and widespread, but not important.

**Crown Gall** *Bacterium tumefaciens* Erw. Sm.  
and Towns.

Occurs in all sections where pears are grown: serious in some localities.

**Leaf Blight** *Fabraea maculata* (Lév.) Atk.

Widespread; occurring on fruit and leaves. May become a serious pest in a nursery.

**Leaf Spot** *Septoria piricola* Desm.

Fairly common in Eastern Cape. Not serious.

**Scab** *Venturia pirina* Aderh.  
[= *Fusicladium pirinum*  
(Lév.) Fekl.).

Prevalent throughout the Cape: also occurs at times in the other provinces.

**Silver Leaf** *Stereum purpureum* Fr.

Occurs at Stellenbosch, Cape; unknown elsewhere.

**Sour Sap** Non-parasitic.

Occurs to some extent in South-western Cape.

## **PEARL MILLET** (*Pennisetum glaucum* R. Br.).

**Leaf Spots** *Macrosporium* sp., *Phoma* sp.

Reported from Tweespruit, Orange Free State.

**Smut** *Tolyposporium* *Penicillaria* Bref.

Only known to occur in Portuguese East Africa.

## **PELARGONIUM** (*Pelargonium* sp.).

**Leaf Spot** *Septoria Pelargonii* Syd.

Fairly common in South-western Cape.

## **PEPPER TREE** (*Schinus molle* L.).

**Anthracnose** *Gloeosporium* sp.

Reported from Eastern Cape and Natal; caused considerable damage at Maritzburg on one occasion.

**Leaf Spot** ? *Bacterium* sp.

Only known at Irene, Transvaal.

## **PEPPER.** See **CHILLI.**

## **PERENNIAL RYE GRASS** (*Lolium perenne* L.).

**Rust** *Puccinia coronata* Cda.

Found at Potchefstroom Transvaal.

**PERSIMMON** (*Diospyros virginiana* L.).

**Damping off** *Fusarium* sp.

Found at Vereeniging, Transvaal.

**PETUNIA** (*Petunia* sp.).

**Dodder** *Cuscuta arvensis* Beyr.

Occasionally attacks this host.

**PHLOX** (*Phlox Drummondii* Hk.).

**Leaf Spot** *Cercospora omplacodes* Ell. and Hol.

Cramond, Natal.

**Leaf Spot** *Septoria Drummondii* Ell. and Ev.

Stellenbosch, Cape.

**PINE** (*Pinus* spp.).

**Die-Back** *Diplodia pinca* Kickx.

Occurs commonly.

**Minor Troubles**

Caused by *Coniothecium* sp., *Fusarium* sp., *Naemocyclus niveus* (Pers.) Sacc., *Pestalozzia funerea* Desm., *P. Hartigii* Tub., *Pestalozzia* spp., *Phoma pinicola* (Zopf) Sacc., *Ph. abietina* Hartig., *Phoma* spp., *Thelephora terrestris* Ehrh.

Recorded from a number of localities, but apparently not responsible for serious injury.

**Sooty Mould** *Capnodium Pini* B. and C.

Following insect infestation.

**PINEAPPLE** (*Ananas sativus* Schult.).

**Black Spot** *Penicillium* spp.

Common in Eastern Cape, especially Bathurst District and in Natal. Troublesome in fruit handled by canneries.

**Root Rot, Crown Rot** Cause unknown.

Occurs to a slight extent in Bathurst District, Cape.

**PLANE** (*Platanus* sp.).

**Canker** *Cytospora* sp.

Greytown, Natal.

**PLUM** (*Prunus salicina* Lindl.).

**Brown Rot** *Sclerotinia fructigena* (Pers.) Schroet.

Retreat, Cape. Uncommon.

**Crown Gall** *Bacterium tumefaciens* Sm. and Towns.

Common and widespread.

- Chlorosis** Non-parasitic.  
Common in South-western Cape.
- Die-Back** *Cytospora leucostoma* Sacc.  
(= *Valsa leucostoma* (Pers.) Fr.)  
Fairly common in Transvaal and Orange Free State: usually attacks trees which are in poor condition.
- Die-Back** *Botryosphaeria* sp.  
Du Toit, Cape. Uncommon.
- False Silver Leaf** Non-parasitic.  
Fairly common in the South-western Cape).
- Gummosis** Non-parasitic.  
Fairly common.
- Kelsey Spot** Non-parasitic.  
Occurs in South-western Cape where it sometimes causes considerable loss.  
Has also been seen on the Rand, Transvaal.
- Rust** *Puccinia pruni-spinosae* Pers.  
(= *Tranzschelia punctata* Arth.).  
Common in South-eastern and South-western Cape, and also occurs in Transvaal.
- Shot Hole** *Bacterium* sp.  
Reported from a few localities in Cape, Natal and Transvaal: not of much importance.
- Silver Leaf** *Stereum purpureum* Fr.  
Common in South-western Cape.
- Thread Blight** ? *Corticium* sp.  
Hilton Road, Natal and Louis Trichardt, Transvaal. Causes die-back of affected branches.
- Trunk Rot** *Schizophyllum commune* Fr.  
Only known in the South-western Cape; of little importance.
- POPLAR** (*Populus* spp.).
- Canker** *Nectria* sp.  
In South-western Cape: not common.
- Crown Gall** *Bacterium tumefaciens* Erw. Sm. and Towns.  
Fairly common on poplars.
- Leaf Curl** *Taphrina aurea* Fr.  
Fairly common in the winter rainfall area, South-western Cape.
- Leaf Spot** *Marssonina Castagnei* Desm. and Mont.  
In Western Cape and in Natal; fairly common.
- Rust** *Melampsora accidioides* Schroet.  
Found in South-western Cape, Natal and Northern Transvaal.

**PORT JACKSON WILLOW** (*Acacia saligna* Wendl.).**Leaf Spot***Diplodia lichenopsis* Cke. and Mass.

Said to occur at Somerset West.

**POTATO** (*Solanum tuberosum* L.).**Bacterial Wilt***Bacterium solanacearum* Erw. Sm.

A very common wilt, particularly troublesome in Natal and Northern Transvaal.

**Black Dot***Colletotrichum atramentarium* (Berk. and Br.) Taubh.

Fairly frequent in Natal and Transvaal; does not usually cause serious damage.

**Black Heart**

Non-parasitic.

Appears in tubers subjected to high temperatures; often found in tubers improperly stored.

**Black Leg***Bacillus phytophthorus* Appel.  
(= *B. atrosepeticus* v. Hall).

Not very common; reported several times from Natal and once from Orange Free State.

**Common Scab***Actinomyces scabics* (Thaxt.) Guss.

Very common and widespread.

**Corky Scab, Powdery Scab***Spongospora subterranea* (Wallr.) Lagerh.

Outbreaks infrequent; imported seed showing powdery scab lesions frequently produces sound crop. South African conditions in most potato growing areas appear to be unsuited to the development of this organism.

**Dry Rot***Fusarium* spp.

A common storage rot.

**Early Blight***Alternaria solani* (Ell. & Mont.),  
Jones & Grout. (= *Macrosporium solani* Ell. and Mart.).

Extremely prevalent in all provinces; one of the most common and widespread of the potato diseases in South Africa, often seriously affects yield.

**Glassy Centre**

Non-parasitic.

Occasional.

**Hollow Heart**

Non-parasitic.

Fairly frequent when period of dry heat is followed by heavy rains.

**Internal Brown Fleck**

Cause unknown.

A very common trouble, especially severe on the high veld; much influenced by seasonal climatic conditions, and soil factors.

**Late Blight, Irish Potato Blight***Phytophthora infestans* De By.

Not very common, but sporadic outbreaks occasionally occur when moisture and temperature conditions are suitable.

**Leak or Soft Rot** *Pythium aphanidermatum* (Eds.) Fitz.  
Probably quite a common rot of potatoes, especially at high temperatures.

**Mosaic** Virus.  
Occurs fairly frequently.

**Rhizoctonia, Stem Canker, Black Scurf** *Corticium solani* Bourd and Galz.

The sclerotial form is extremely common on tubers; the stem canker and "little potato" lesions occur less frequently.

**Sclerotium Wilt** *Sclerotium Rolfsii* Sacc.  
Occasional in Natal and Transvaal.

**Tip Burn** Non-parasitic.  
Very prevalent in the Constantia district, Cape.

**Wart Disease, Black Scab** *Synchytrium endobioticum* (Schilb.) Perc.  
Introduction of infected "seed" guarded against by legislation; only two outbreaks have occurred, one in Natal and one in Transvaal, near Johannesburg. Eradication and quarantine measures adopted are so far successful in preventing recurrence of disease.

**Wilt** *Verticillium albo-atrum* Reinke and Bert.  
Recorded from the Cape Province.

#### **PRICKLY PEAR** (*Opuntia* sp.).

**Scab** Non-parasitic.  
Cape and Transvaal.

#### **PRIDE OF DE KAAP** (*Bauhinia Galpini* N.E. Br.).

**Yeast Spot, Pod Spot** *Nematospora* sp.  
On pods of plants in Pretoria: these plants seldom produce viable seed, largely on account of this infection.

#### **PROTEA** (*Protea* spp.).

**Leaf Spots** *Entopeltis interrupta* Wint., *Leptosphaeria Protearum* Syd., *Oligostroma maculiformis* (Wint.) Doidge, *Phacosphaerella senniana* (Wint.) Sacc., *Phyllachora Proteae* Wakefield, *Teratosphaeria fibrillosa* Syd., *Thyriopsis Proteae* v. d. Byl.

Leaf Spots are common on most of the *Protea* spp.

**Sooty Mould** *Didymosporium congestum* Syd.  
Transvaal, on *Protea abyssinica*.

#### **PRUNE** (*Prunus domestica* L.). See under **PLUM**.

**PUMPKIN** (*Cucurbita Pepo* L.).**Mildew***Erysiphe cichoracearum* D.C.

Very common and widespread; may be destructive in wet weather.

**QUINCE** (*Cydonia vulgaris* Pers.).**Bitter Rot***Glomerella cingulata* (Stonem.)

Sp. and Van Schr.

One record from Natal, but is probably more common than this would imply.

**Black Rot***Physalospora Cydoniae* Hes.

Fairly common in the Cape Province.

**Crown Gall***Bacterium tumefaciens* Sm. and Towns.

Common and widespread.

**Leaf Blight, Fruit Blotch***Fabraea maculata* (Lév.) Atk.(=*Entomosporium maculatum* Lév.).

Common on leaves and fruit; the perfect stage of this fungus has not been found in South Africa.

**RADISH** (*Rhaphanus sativus* L.).**Downy Mildew***Peronospora parasitica* De By.

Said to occur at Groot Drakenstein, Cape.

**White Rust***Cystopus candidus* (Pers.) De By.

Reported from Stellenbosch, Cape.

**RASPBERRY** (*Rubus idaeus* L.).**Crown Gall***Bacterium tumefaciens* Sm. and Towns.

Occurs in South-western Cape.

**RED ELDER, ROOI ELS** (*Cunonia capensis* L.).**Leaf Spot***Diathrypton radians* Syd.

In the Knysna forest, Cape.

**RED MILKWOOD, ROOI MELKHOUT** (*Mimusops obovata* Sond.).**Leaf Mould***Asterinella mimusopsidis* Doidge.

Eastern Cape.

**RED STINKWOOD, ROOI STINKHOUT** (*Pygeum africanum* Hk. f.).**Leaf Mould***Irene ealostroma* (Desm.) v. Höhn.**RESCUE GRASS, BROME** (*Bromus unioloides* H.B.K.).**Rust***Puccinia bromina* Eriks.

Said to occur at Stellenbosch, Cape.

**Smut** *Ustilago bromivora* (Fisch.) de Wahl.  
Common; reported from Transvaal, Cape and Orange Free State.

**RHODES GRASS** (*Chloris gayana* Kth.).

**Rust** *Puccinia Chloridis* Speg.  
Recorded from Pretoria District, Transvaal and Rhodesia.

**Smut** *Tolyposporium chloridis* P. Henn.,  
Only known in Natal.

**RHUBARB** (*Rheum raphaniticum* L.).

**Crown Rot** *Phytophthora parasitica* Dors.,  
var. *Rhei* Godfrey.  
Fairly common in Transvaal and Cape.

**Rust** *Accidium rubellum* Gmel. [—*Puccinia phragmites* (Schum.) Korn.].  
Found occasionally in Natal, Transvaal and Cape.

**ROOI-BLAAR.** See **BUSH-WILLOW.**

**ROOI ESSENHOUT.** See **NATAL MAHOGANY.**

**ROOI GRAS** (*Themeda triandra* Forsk.).

**Rust** *Puccinia versicolor* Diet. and Holw.  
Fairly common in Transvaal.

**Smut** *Sorosporium Holstei* P. Henn.  
Fairly common in Transvaal.

**ROSE** (*Rosa* spp.).

**Black Spot** *Diplocarpon Rosae* Wolf.  
[= *Actinonema Rosae* (Lib.) Fr.].  
Common and widespread; the perfect stage of the fungus has not been found.

**Crown Gall** *Bacterium tumefaciens* Sm. and Towns.  
Common and widespread.

**Mildew** *Sphaerotheca pannosa* (Wallr.) Lévy.  
Common; especially severe in damp and shaded situations. Some varieties, e.g. Crimson Rambler and the Dog Rose are very susceptible.

**Rust** *Phragmidium disciflorum* (Tode) James.  
[= *Phr. mucronatum* (Pers.) Schl.].  
(= *Phr. subcorticium* Wint.).

Widely distributed, but less common than mildew and black Spot.

**Stem Canker** *Coniothyrium Fuckelii* Sacc.

Of common occurrence, and sometimes very destructive, especially in the nursery.

**ROSELLE, INDIAN SORREL** (*Hibiscus sabdariffa* L.).**Wilt**? *Fusarium* sp.

Natal and Northern Transvaal; plants wilted suddenly, roots were found to be rotten and wood at crown shewed brown discolouration.

**RUNNER BEAN.** See **FRENCH BEAN.****RYE** (*Secale cereale* L.).**Black Rust***Puccinia graminis* Pers.

Occurs in Cape and Transvaal.

**Brown Rust***Puccinia dispersa* Eriks. and Henn.

Occurs in Natal and Transvaal.

**Stem Smut, Stripe Smut***Urocystis oeculta* (Wallr.) Rabh.

Reported from Robertson and Stellenbosch, Cape.

**SAFRAAN** (*Elaeodendron* spp.).**Leaf Moulds**

*Asterodonthis solaris* (K. and Cke.) Th.,  
*Asterinella disseliens* Syd.

The former is common, and seedlings are often seriously attacked.

**SALSIFY** (*Scorzonera hispanica* L.).**White Rust***Cystopus cubicus* (Strauss) De By.

Reported from Stellenbosch and Paarl, Cape.

**SEVILLE ORANGE** (*Citrus aurantium* L.).**Verrucosis or Scab**

*Sporotrichum Citri* Butl.  
(=*Sphaceloma Fawcetti* Jenkins).

Common in the "mist belt" of Natal and Transvaal.

**SHASTA DAISY** (*Chrysanthemum maximum* Ram.).**Leaf Spot***Septoria? chrysanthemella* Cav.

Range not ascertained, but probably common and widespread; has been known to be destructive in wet seasons at Pretoria, Transvaal.

**SHIRLEY POPPY** (*Papaver Rhoeas* L.).**Root Rot***Rhizoctonia* sp.

Pretoria, Transvaal.

**SISAL HEMP** (*Agave sisalana* Perr.).**Leaf Spot***Colletotrichum Agaves* Cav.

Occurs in the Natal coast.

**Leaf Scorch**

Non-parasitic.

Common in Natal and Transvaal.



**SNAPDRAGON** (*Antirrhinum* spp.).**Leaf Spots***Cercospora* sp.,  
*Septoria Antirrhini* Desm.

Said to occur at Claremont, Cape.

**Stem Rot***Phoma* sp.

One record from East London, 1917 ; not confirmed.

**Wilt***Fusarium* sp., *Rhizoctonia* sp.

Common and widespread.

**SNEEZEWOOD, NIESHOUT** (*Placoxylon utile* Eck. and Zeyh.).**Trunk Rot***Fomes rimosus* Berk.

Knysna and Eastern Cape.

**SORREL, SURING** (*Oxalis* spp.).**Rust***Aecidium Oxalidis* Thuem.

Occurs on several species of *Oxalis*, but only the form on *Oxalis corniculata* has been proved to be the aecidial form of *Puccinia Maydis* Bereng. This aecidial stage is comparatively rare.

**SOY BEAN** (*Glycine hispida* Max.).**Bacterial Blight***Bacterium ? glycineum* Coerper.

Only recorded from Magut, Natal, and Pretoria, Transvaal.

**Downy Mildew***Pecronospora trifoliorum* De Bary.

Caused considerable damage to seedlings grown under greenhouse conditions at Cedara, Natal.

**Leaf Blight***Alternaria* sp.

Reported from Cedara, Natal, as causing considerable damage to the variety American Flat Brown ; other varieties less seriously attacked.

**Leaf Spot***Phoma* sp.

Reported from Cedara, Natal.

**Mildew***Erysiphe Polygoni* D.C.

Cedara, Natal.

**Sclerotium Wilt***Sclerotium Rolfsii* Sacc.

Only one record from Barberton, Transvaal.

**SPEAR GRASS** (*Heteropogon contortus* L.).**Black Spot***Linchorella striiformis* Syd.

Found in Pretoria District, Transvaal.

**Rust***Puccinia versicolor* Diet. and Holw.

Pretoria District.

**SQUASH.** See **MARROW.**

**SPINACH BEET.** See **BEET.**

**SPINELELESS CACTUS** (*Opuntia* sp.).

**Brown Pocket**

Non-parasitic.

Characterised by presence of brown pockets inside of leaves apparently sound; suspected of being toxic to sheep; Experiment Station, Pretoria.

**Corky Scab**

Cause unknown.

Common and widespread; may cause considerable damage in dry seasons.

**SQUILL** (*Scilla* spp.).

**Rust**

*Uromyces circinalis* K. and Cke.

Eastern Cape; only one record.

**Smut**

*Ustilago Vaillantii* Tul.

In ovaries; fairly common in Natal and Transvaal.

**STAR GRASS** (*Cynodon plectostachyum* Pilg.).

**Black Spot**

*Phyllachora Cynodontis* (Sacc.) Niessl.

Rather severe at Cedara, Natal.

**STERRETJE.** See **HYPOXIS.**

**STINKWOOD, STINKHOUT** (*Ocotea bullata* E. Mey.).

**Leaf Mould**

*Morenoella Phillipsii* Doidge.

On leaves in the Knysna District; frequently clothing the stems of seedlings over considerable areas.

**Trunk Rot**

*Fomes geotropus* Cke.

Knysna: *F. hornodermis*, *F. applanatus*, and *Lenzites repanda* have also been found on this host in the forests of the Cape Coast and Pondoland.

**STOCK** (*Mathiola incana* R. Br.).

**Wilt**

*Fusarium* sp.

Fairly common.

**STRAWBERRY** (*Fragaria* spp.).

**Brown Rot**

*Botrytis* sp.

Found occasionally in Transvaal.

**Fruit Rot**

*Rhizopus* sp.

Common in fruit exposed for sale.

**Leaf Spot**

*Mycosphaerella Fragariae* (Tvl.) Lind.

Common and widespread.

**Sclerotium Wilt**

*Sclerotium Rolfsii* Sacc.

One record from Transvaal, 1919.

**SUDAN GRASS** (*Sorghum sudanense* Stapf.).

- Downy Mildew** *Sclerospora graminicola* Schröt.  
Reported from Zululand.
- Leaf Blight** *Helminthosporium* sp.  
Causes severe damage at times in Natal.
- Rust** *Puccinia purpurea* Cke.  
Reported from Schoombie, Cape.

**SUGAR BEET.** See **BEET.****SUGAR CANE** (*Saccharum officinarum* L.).

- Chlorosis, Lime Chlorosis** Non-parasitic.  
Occurs generally through cane fields of Natal and Zululand; attributed to lowering of amount of available iron during early stages of growth.
- Leaf Blight** *Helminthosporium Sacchari* Butl.  
Occurs throughout the Natal Coast belt.
- Mosaic** Virus.  
Widely distributed in Natal upon every variety of cane, except Uba; is being dealt with by the eradication of susceptible varieties. Insect carrier is *Aphis maidis* Fitch.
- Ring Spot** *Leptosphaeria Sacchari* v. Breda.  
Natal, throughout the coastal area.
- Sectional Chlorosis, Cold Chlorosis** Non-parasitic.  
Occurs generally in the cane fields of Natal and Zululand; attributed to low temperatures during winter months, resulting in inhibition of chlorophyll production.
- Streak** Virus.  
An infectious chlorosis of sugar cane not identical with mosaic, and affecting Uba as well as a number of other varieties.  
Insect vector is *Balclutha mbila* Naude.
- Wilt** *Cephalosporium Sacchari* Butl.  
Has been found in various localities on Natal Coast.

**SUNFLOWER** (*Helianthus annuus* L.).

- Leaf Blotch** *Septoria Helianthi* Ell. and Kell.  
Fairly common.

**SURING.** See **SORREL.****SWEDE** (*Brassica Rapa* L.).

- Club Foot** *Plasmodiophora Brassicae* Wor.  
Reported from South-western Cape.
- Soft Rot** *Bacillus carotovorus* Jones.  
Only one record from Natal, but may be fairly common.

**SWEET GRASS** (*Chloris virgata* Schwartz.).**Rusts**

*Puccinia chloridis* Speg.,  
*Uromyces Chloridis* Doidge.

Pretoria District, Transvaal; the former species also found in Natal Coast.

**SWEET GRASS** (*Panicum laevifolium* Hack.).**Rust**

*Uromyces leptodermus* Syd.

Transvaal and Orange Free State.

**Smut**

*Sorosporium* sp., *Ustilago* sp.

Transvaal: The *Sorosporium* has also been found in Natal.

**Witchweed**

*Striga lutea* Lour.

Observed at Marikana, Transvaal.

**SWEET PEA** (*Lathyrus odoratus* L.).**Mildew**

*Erysiphe Polygoni* D.C.

Common and widespread; only oidial stage found.

**Streak**

*Bacillus Lathyri* Manns and Taub.

Reported from the neighbourhood of Capetown.

**Wilt**

? *Fusarium* sp.

A common trouble; cause not fully investigated.

**SWEET POTATO** (*Ipomoea batatas* Poir.).**Brak Injury**

Non-parasitic

Recorded at Little Brak R., Cape, 1923.

**Root Parasite**

*Striga orobanchoides* Benth.

At Groot Marico, Transvaal; in 1923, large areas of plants were destroyed by this parasite.

**Scab**

*Actinomyces* sp.

Reported from Little Brak R., Oudtshoorn, Cape, in 1923.

**Storage Rots**

*Rhizopus nigricans* Ehbg.,  
*Pythium ultimum* Trow.,  
*Fusarium* sp.

Fairly common.

**SWEET WILLIAM** (*Dianthus barbatus* L.).**Leaf Spot**

*Septoria Dianthi* Desm.

Reported from Wynberg, Cape.

**Rust**

*Uromyces caryophyllinus* (Schr.) Wint.

Said to occur at Wynberg and Constantia, Cape.

**SWORD BEAN** (*Canavalia gladiata* D.C.).**Rust** *Uredo* sp.

One record from Citrus, Transvaal.

**Sclerotium Wilt** *Sclerotium Rolfsii* Sacc.

Reported from Barberton, Transvaal.

**TALL FESCUE** (*Festuca elatior* L.).**Ergot** *Claviceps* sp.

Reported from Potchefstroom, Transvaal, and Cape.

**TAMARISK** (*Tamarix* sp.).**Twig Blight** *Phoma* sp.

One record. Steynsburg, O.F.S., 1923.

**TAMBUTI GRASS** (*Cymbopogon validus* Stapf.).**Rust** *Puccinia erythracensis* Pazschke.

Pretoria, Transvaal.

**Smut** *Sorosporium Tambuti* P. Henn.

Reported from Northern and Eastern Transvaal.

**TEFF** (*Eragrostis abyssinica* Schrad.).**Rust** *Uromyces pedicellata* Pole Evans.

Fairly common in Transvaal.

**Witchweed, Rooibloom** *Striga lutea* Lour.

Fairly common.

**TEOSINTE** (*Euchlaena mexicana* Schrad.).**Streak** Virus.

On the Natal Coast.

**Witchweed, Rooibloom** *Striga lutea* Lour.

Locality not recorded.

**TEPARY BEAN** (*Phaseolus acutifolius* var. *latifolius* Freem.).**Anthracnose** *Colletotrichum* sp.

On pods and stem; causes considerable damage. Reported from Immerpan, Northern Transvaal.

**Fusarium Wilt** *Fusarium* sp.

Reported from Immerpan; extent of damage unknown.

**Root Rot** *Rhizoctonia* sp.

Occurs in Swaziland and Northern Transvaal.

**Sclerotium Wilt** *Sclerotium Rolfsii* Sacc.

Only known to occur at Barberton, Transvaal.

**TERBLANS** (*Faurea MacNaughtonii* Phillips).

- Black Dot** *Hysterostoma Faureae* Doidge.  
In the George and Knysna Forests, Cape.

**TOBACCO** (*Nicotiana tabacum* L.).

- Angular Leaf Spot** *Bacterium angulatum* Fromme and Murr.  
Occasional in the Union, but not usually serious; is common in Southern Rhodesia.

- Bacterial Wilt** *Bacterium solanaccarum* Erw. Sm.  
Has been reported twice from the Natal Coast in 1913, and 1915.

- Broom Rape** *Orobanche ramosa* L.  
Reported from Cape, Paarl, and Stellenbosch Divisions, Cape Province.

- Damping off** (1) *Fusarium moniliforme* Sheld.,  
(2) *Phoma* sp., (3) *Pythium* sp.,  
(4) *Rhizoctonia* sp.  
(1) Occasional in seed beds, (2) one record from South-western Cape,  
(3) locally serious in Transvaal, (4) common in the Transvaal.

- Dodder** *Cuscuta appendiculata* Engelm.  
Found on *Nicotiana glauca* Gmel. at Kimberley.

- Frog-eye Leaf Spot** *Cercospora Nicotianae* E. and E.  
(One record from Swaziland; common in Southern Rhodesia).

- Fusarium Wilt** *Fusarium oxysporum* Schlecht. var.  
*Nicotianae* Johns.  
Locally serious in certain seasons. The above organism is found in all parts of affected plants, but pathogenicity has not been fully proved.

- Leaf Spot** *Ascochyta Nicotianae* Pers.  
Recorded once from the Transvaal, 1907.

- Mildew, White Rust** *Oidium Tabaci* Thum.  
Very common; attacking mainly the lower leaves and occasionally causing serious damage in wet weather when the plants are of rank growth and stand close together.

- Mosaic** Virus.  
Of universal distribution, occasionally causing appreciable loss, through stunting of plants and scorchlike spotting of leaves in some varieties.

- Red Rust** *Alternaria longipes* (Ell. and Ev.) Mason  
(= *Macrosporium longipes* Ell. and Ev.).

A leaf spot of common occurrence late in the season.

- Root Rot** *Thielavia basicola* Zopf.  
Severe locally.

- Sclerotium Wilt** *Sclerotium Rolfsii* Sacc.  
One record from the Transvaal; also occurs on *Nicotiana rustica*.

**White Speck**

*Alternaria tabacum* (Ell. and Ev.) Hori.  
(= *Macrosporium tabacinum* Ell. and Ev.).

Has been reported on four occasions.

**Wild Fire**

*Bacterium tabacum* Wolf & Foster.

The most serious tobacco disease in the Union, occurring in almost all districts. Its spread is favoured by wet weather, especially if accompanied by wind and hail. In the seedbed a severe attack may lead to wholesale destruction of the plants (as in the Turkish tobacco in South-western Cape); in the field the disease attacks the lower leaves first, but under favourable conditions it spreads rapidly to the top of the plant and in a few days may render the whole crop worthless.

**Witchweed**

*Striga lutea* Lour.,  
*S. orobanchoides* Benth.

Each reported once on *Nicotiana rustica*.

**TOMATO** (*Lycopersicum esculentum* Mill).**Anthraxnose**

*Colletotrichum phomaoides* (Sacc.)  
Chester.

Appears occasionally as a ripe rot of the fruit.

**Bacterial Wilt**

*Bacterium solanacearum* Erw. Sm.

Widely distributed and often very destructive.

**Blossom End Rot**

Non-parasitic.

Of very common occurrence: attributed largely to an uneven water supply during periods of intense heat.

**Broom Rape**

*Orobanche ramosa* L.

Reported from Cape, Paarl and Stellenbosch Divisions, Cape Province.

**Bunchy Top**

Virus.

Distributed fairly widely in Eastern Transvaal. No chlorosis evident, but plants show general dwarfing, reduction in size of leaves and shortening of internodes. Little or no fruit is developed. Very infectious, transmission by contact.

**Canker**

*Bacterium vesicatorium* Doidge.

Recorded only from Transvaal, but is very probably more widely distributed. Often becomes destructive during the latter part of the summer.

**Early Blight**

*Alternaria Solani* (Ell. and Mart.)  
Jones and Grout. [= *Macrosporium Solani* (Ell. and Mart.)].

Common and widely distributed, especially on the fruit; may also disastrously attack young plants in the seed bed.

**Fruit Rot**

*Phoma destructiva* Plour.

A fairly common fruit rot.

**Fusarium Wilt**

*Fusarium Lycopersici* Sacc.

Prevalent in the tomato fields of Eastern Transvaal.

- Late Blight** *Phytophthora infestans* De By.  
Only one outbreak recorded on the Natal Coast in 1922.
- Leaf Spot** *Septoria Lycopersici* Speg.  
Prevalent wherever tomatoes are grown, and may be severe and destructive when conditions are favourable for its development.
- Mosaic** Virus.  
Very prevalent in all tomato-growing areas, especially towards the end of the season.
- Mouldy Fruit Rot** *Rhizopus stolonifer* (Ehr.) Lind.  
(=*R. nigricans* Ehr.).  
Common as a storage rot, especially in fruit which is over ripe or injured in any way.
- Sclerotium Wilt** *Sclerotium Rolfsii* Sacc.  
Occurs occasionally, when conditions are suitable, causing a rapid wilting and yellowing of the plant.
- Streak** ? *Bacillus Lathyri* Manns and Taub.  
Only one outbreak recorded in Transvaal; plants had received an over-supply of nitrogenous fertiliser.
- Yellow Blight** *Fusarium oxysporum* Schlecht  
*F. orthoceras* App. and Wr.  
Occurs in Eastern Transvaal. These organisms cause a gradual yellowing and stunting of the plants; never a typical wilt.

**TRAVELLER'S JOY.** See **WILD CLEMATIS.**

**TRIFOLIATE ORANGE** (*Poncirus trifoliata* Raf.).

- Die Back** *Diplodia natalensis* Pole Evans.  
Known to occur in the Natal Coast.

**TULP** (*Homeria* spp.).

- Rust** *Puccinia Moraeae* P. Henn.  
On *Homeria pallida* Bkr. in Transvaal, and *Homeria* sp. Cape.

**TURNIP** (*Brassica Rapa* L.).

- Black Rot** *Bacterium campestre* (Pam.) Sm.  
Occasional; far less frequent on turnip than on cabbage and cauliflower.
- Club Root, Finger and Toe** *Plasmodiophora Brassicae* Wor.  
Has been known to occur in Natal and in South-western Cape.
- Mildew** *Erysiphe Polygoni* D.C.  
One record from Aberdeen, Cape, in 1927.
- Soft Rot** *Bacillus carotovorus* Jones.  
One record from Natal, 1922.
- White Rust, White Blister** *Cystopus candidus* (Pers.) De By.  
One record from New Hanover, Natal, in 1917.



**TURPENTINE GRASS** (*Cymbopogon excavatus* Stapf.).

- Rust** *Puccinia erythraeensis* Pazschke.  
Pretoria District.
- Smuts** *Sorosporium Tambuti* P. Henn  
*Ustilago Ischacini* Fekl.  
Locality not recorded.

**UMZIMBEET** (*Milletia caffra* Meisn.).

- Rust** *Diorchidium Woodii* K. and Cke.  
Common near the Natal Coast.

**VAALBOS** (*Brachylaena discolor* D.C.).

- Rust** *Uredo Brachylaenae* Doidge.  
Only recorded from Durban, Natal.

**VELVET BEAN** (*Stizolobium Deeringianum* Bort.).

- Leaf Spot** *Phyllosticta* sp.  
Reported from Rustenburg, Transvaal only.

**VERBENA** (*Verbena hybrida* Voss.).

- Mildew** *Oidium* sp.  
One record from Fish Hoek, Cape.

**VIOLET** (*Viola odorata* L.).

- Leaf Spots** *Alternaria Violae* (Gall.) Dors.,  
*Cercospora Violae* Sacc.,  
*Phyllosticta Violae* Desm.  
Fairly frequent and widespread, especially the first two.

**VLIER** (*Nuxia floribunda* Benth.).

- Leaf Mould** *Irene Nuxiae* Syd.  
Occurs commonly on this host.

**VYGIES.** See **MESEMBRYANTHEMUM.****WALK GRASS** (*Poa annua* L.).

- Rusts** *Puccinia coronata* Cda.,  
*P. poarum* Niels.  
Said to occur at Stellenbosch, Cape.

**WALNUT** (*Juglans* spp.).

- Anthraxnose** *Gloeosporium epicarpii* Thum.  
Has been found on a few occasions on fruits in Natal and Cape.

**Bacterial Blight***Bacterium Juglandis* Pierce.

Very prevalent, especially where there are driving rains and overcast skies during the growing period.

**Crown Gall***Bacterium tumefaciens* Sm. and Towns.

Has been found on walnut in the Cape Province.

**Leaf Blotch**

*Marssonina Juglandis* (Lib.) Magn.  
[= *Marssonina Juglandis* (Lib.) Sacc.].

Only two records from Natal and Transvaal, but may be more common than this would indicate. The perfect stage [*Gnomonia leptostyla* (Fr.) Ces. and de Not.] has not been found in South Africa.

**Leaf Spot***Cercospora Juglandis* Kell. and Sw.

Caused defoliation at Centocow, Natal, 1916.

**WATERHOUT.** See **CAPE HOLLY.****WATER MELON** (*Citrullus vulgaris* Schrad.).**Anthraxnose***Colletotrichum lagenarium* (Pass.) Sacc.

Only two records, Pretoria, Transvaal, and Stellenbosch, Cape.

**Fusarium Wilt***Fusarium* sp.

Caused wilting of seedlings, Pyramids near Pretoria, 1924.

**Mildew***Erysiphe cichoracearum* DC.

Fairly common.

**WATERPEER** (*Eugenia Gerrardi* Sim.).**Leaf Mould***Meliolina cladotricha* (Lév.) Syd.

Northern Transvaal.

**WATSONIA** (*Watsonia* spp.).**Rust***Uromyces Watsoniac* Syd.

Transvaal and Cape.

**WATTLE** (*Acacia mollissima* Willd.).**Crown Gall***Bacterium tumefaciens* Sm. and Towns.

Occasional.

**Leaf Spot***Stigmina verruculosa* Syd.

In wattle plantations in Natal.

**Mottling**

Non-parasitic.

Trunk and branches show darkened patches which later crack and exude gum; attributed to physiological disturbance caused by heavy soils, and heavy rains following a prolonged drought.

**WAX BERRY BUSH** (*Myrica cordifolia* L.).**Black Scab, Tar Spot**

*Dothidina disciformis* (Wint.)  
Th. and Syd.

Cape Coast and Natal.

**WHEAT** (*Triticum aestivum* L. = *T. vulgare* Vill.).

**Brown Rust, Orange Leaf Rust** *Puccinia triticea* Eriks.  
Rare.

**Black Chaff** *Bacterium translucens* J. J. and  
R. var. *undulosum*.  
Malmesbury District, Cape.

**Black Rust** *Puccinia graminis* Pers.  
Very common; destructive when conditions are favourable.

**Bunt, Stinking Smut** *Tilletia caries* (D.C.) Tul.  
[= *T. Tritici* (Bjerk) Wint.].  
*T. foetens* (B. and C.) Tul.  
(= *T. laevis* Kühn.).  
*Tilletia caries* is generally distributed; *T. foetens* is less common.

**Flag Smut** *Urocystis Tritici* Körn.  
Sometimes destructive in South-western Cape and Transvaal.

**Foot Rot, Vrotpootje** *Helminthosporium sativum* (Pam.)  
King and Bakke.  
Very common in the wheat-growing areas of the Transvaal and Eastern Cape. From a foot rot of this type *Fusarium culmorum* was isolated on one occasion, but is evidently comparatively rare.

**Glume Blotch** *Septoria nodorum* Berk.  
South-western Cape.

**Leaf Spot** *Septoria Tritici* Desm.  
Found in the Cape Province.

**Loose Smut** *Ustilago Tritici* (Pers.) Jens.  
Cape Province.

**Take-all, Whiteheads** *Ophiobolus graminis* Sacc.  
[= *Ophiobolus cariceti* (B. and Br.)  
Sacc.].  
Chiefly in the winter rainfall area of the South-western Cape.

**Mildew** *Erysiphe graminis* DC.  
Recorded from Transvaal and Eastern Cape.

**WHITE IRONWOOD, WITYSTERHOUT** (*Vepri lanceolata* G. Don.).

**Leaf Mould** *Melicia Toddaliae* Doidge.  
Occurs commonly on this host.

**Rust** *Puccinia kentaniensis* Pole Evans.  
A curious rust found in the Transkei.

**WHITE STINKWOOD** (*Celtis Kraussiana* Benth.).

**Mildew** *Uncinula polychaeta* Doidge.  
Fountains Valley, Pretoria.

**Trunk Rot**

*Daedalea Eatonii* Berk. *Dadealea* sp.,  
*Fomes applanatus* (P.) Wallr.,  
*F. connatus* Fr., *Pleurotus* sp.,  
*Polyporus colossus* Fr., *Polyporus*  
 sp., *Polystictus zonatus* Fr., *Schizo-*  
*phyllum commune* Fr.

*Polyporus colossus* found at Wonderboom, Pretoria ; the other species in the coast forests.

**WHITE PEAR** (*Apodytes dimidiata* E. Mey.).**Leaf Moulds**

*Meliola campylotricha* Syd.,  
*M. cladophila* Syd.

In the forests of Northern Transvaal.

**WILD ALMOND** (*Brabejum stellatifolium* L.).**Sooty Mould**

*Periconiella velutina* (Wint.) Sacc.

South-western Cape.

**WILD ASPARAGUS** (*Asparagus* spp.).**Black Scab**

*Hysterostomina tenella* Syd.

Eastern Cape on *Asparagus striatus* Thun.).

**Rusts**

- (1) *Puccinia Asparagi* D.C.,
- (2) *P. Phyllocladiae* Cke.,
- (3) *P. ramulipes* Doidge.

(1) On *A. Cooperi* Bkr. and *A. plumosus* Bkr., Transvaal and Orange Free State ; has not yet been found on the cultivated Asparagus which is not widely grown.

(2) On *A. falcatus* L., Natal and the Transkei.

(3) On *A. laricinus* Burch. Common in Transvaal and Orange Free State.

**WILD CLEMATIS** (*Clematis brachiata* Thunb.).**Rusts**

- (1) *Colcosporium Clematidis* Barc.,
- (2) *Aecidium Englerianum* P. Henn. and Lind.,
- (3) *Aecidium Clematidis-brachiatae* Doidge.

(1) Natal and Eastern Cape ; (2) widely distributed, forms large leaf and stem tumors (3) Transvaal.

**WILD FIG** (*Ficus* spp.).**Black Spots**

*Trabutia Evansii* Th. and Syd.,  
*T. ficum* (Niessl.) Th. and Syd.,  
*T. nervisequens* (Ling.) Th. and Syd.,  
*Catacnum grammicum*  
 (P. Henn.) Th. and Syd., *Phyl-*  
*lachora amaniensis* P. Henn.

A considerable number of species of *Phyllachoraceae* occur commonly on wild figs.

**WILD GARDENIA.** See **CANDLEWOOD.**

**WILD JASMINE** (*Jasminum angulare* Vahl.).

**Leaf Moulds** *Asterina erysiphoides* K. and Cke.,  
*Meliola genellipoda* Doidge.

In the forests of the Eastern Cape.

**Rust** *Uromyces Hobsoni* Vize.

Natal and Eastern Cape.

**WILDE KATJEPIERING.** See **CANDLEWOOD.**

**WILD OLIVE, OLIENHOUT** (*Olea verrucosa* Link.).

**Black Spots** (1) *Hysteroglyphium Fraxini* (Pers.)  
de Not. var. *Oleasteri* Desm.,  
(2) *Hysterostoma orbiculata* Syd.

(1) Wellington, Cape; (2) Wellington and Port Elizabeth, Cape.

**Leaf Mould** *Asterodithis solaris* (K. and Cke.) Th.

Common and widespread.

**WILD QUINCE, WILDE KWEPER** (*Cryptocarya transvaalensis* Burt Davy.).

**Leaf Mould** *Meliola Cryptocaryae* Doidge.

Northern Transvaal; also on *C. Woodii* and *C. latifolia* in Natal.

**WILLOW** (*Salix* spp.).

**Crown Gall** *Bacterium tumefaciens* Smith and  
Townsend.

Willows throughout the country are very susceptible, the disease is frequently distributed with cuttings.

**Mistletoe** *Viscum obscurum* Thun.

Fort Cunningham, Cape.

**YELLOW WOOD** (*Podocarpus* spp.).

**Black Coral Spots** (1) *Corynelia uberata* Fr.,  
(2) *Tripospora tripos* (Cke.) Lind.

(1) Common on leaves of *Podocarpus Thunbergii* Hk., *P. falcata* R. Br., and *P. elongata* L'Hérit, in the indigenous forests of Natal, Cape, and Transvaal. (2) Has been recorded only on *P. elongata* in Natal and Eastern Cape.

**Leaf Moulds** *Irene Podocarpi* Doidge,  
*Meliola peltata* Doidge.

*Irene Podocarpi* is very common and widespread, *M. peltata* is comparatively rare.

**ZINNIA** (*Zinnia elegans* Jacq., *Z. pauciflora* L.).

**Leaf Blight**

*Macrosporium* sp.

Common ; attacks the lower leaves first and spreads upwards.

**Leaf Spot**

*Entyloma* sp.

Found at Pretoria only, but is probably fairly common.

**ZUURKANOL.** See **ANTHOLYZA.**

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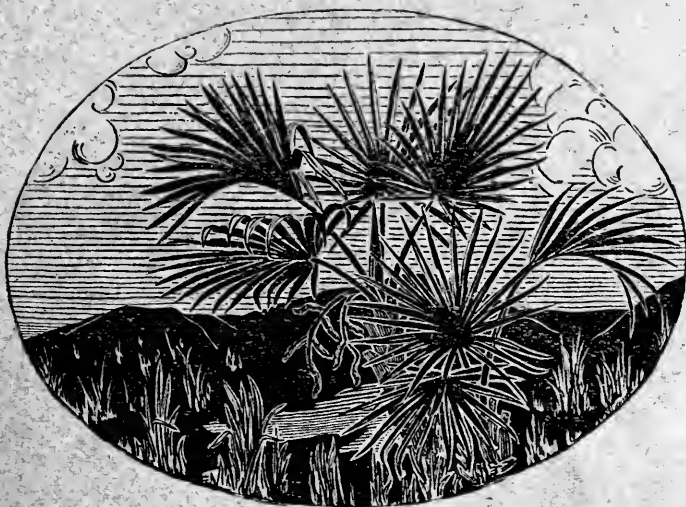
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# BOTANICAL SURVEY OF SOUTH AFRICA

MEMOIR No. 1712

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## BOTANICAL SURVEY OF THE SPRINGBOK FLATS TRANSVAAL



---

By ERNEST E. GALPIN, F.L.S.

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CAPE TOWN :  
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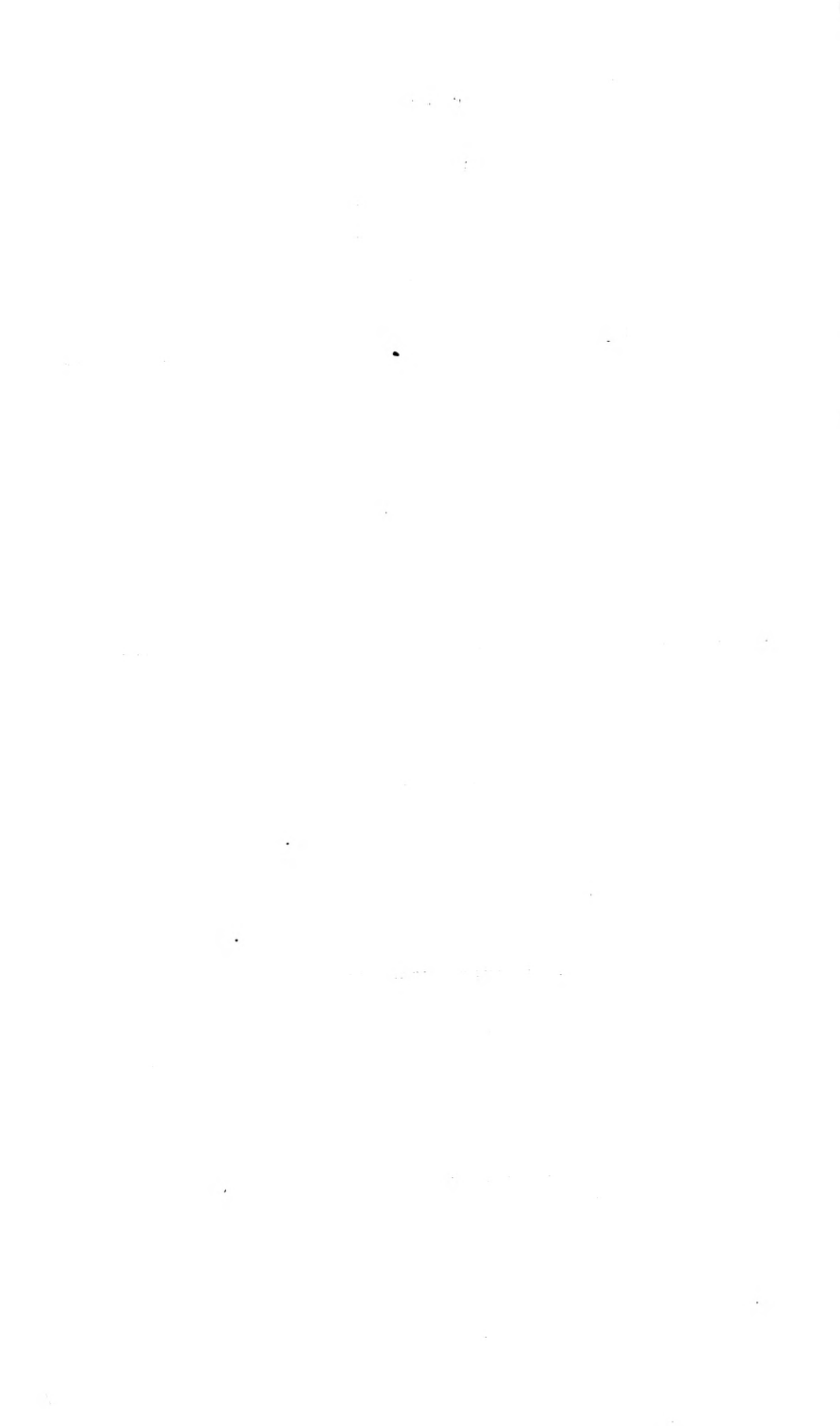
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## INTRODUCTORY.

---

The general survey herein presented has been undertaken at the request of Dr. I. B. Pole Evans, C.M.G., Director of the Botanical Survey of South Africa, to whom I wish specially to tender my thanks for his unfailing courtesy and kindness, and for the very valuable advice and encouragement given me from time to time.

It is based mainly upon my personal observations and collections of the native flora made during a residence of eight years at Mosdene, in the central portion of the Springbok Flats, near Naboomspruit.

Fairly extensive collections of the flora of the middle portion of the Flats, lying to the east of Naboomspruit, have been made, but few opportunities have occurred for making collections of the flora of the southern and northern portions, my knowledge of which has been gained only by hurried visits and by some small collections of the flora of the northern border kindly made for me by Mr. D. F. Gilfillan.

Unfortunately, there are very few records in the *Flora Capensis* of plants collected on the Springbok Flats and a search through the various volumes has only enabled me to add to my list six further species collected by Dr. Burt-Davy, and one by the late Dr. Rudolf Schlechter. Having, therefore, to rely almost entirely upon the results of my own collecting, the list given of the native flora is very far from being complete and must be looked upon as a preliminary one.

Specimens of all the plants enumerated are preserved in the National Herbarium, Pretoria, where the determinations have mainly been made by Dr. E. P. Phillips, the senior botanist, and the members of his staff. The grasses have been determined by Miss Sidney Stent, Government Agrostologist, whilst the *Cyperaceae*, *Crassulaceae* and genus *Rhus* have been determined by Prof. S. Schönland, to all of whom I desire to express my indebtedness and thanks for this and other help given me.

I must further record my obligations to the following gentlemen, whose contributions add very greatly to the value of this memoir :—

To Dr. Percy A. Wagner, of the Geological Survey, for a very valuable chapter contributed on the geology, topography and soils of the Springbok Flats, with accompanying map.

To Dr. B. de C. Marchand, Senior Chemist, Department of Agriculture, for kindly supplying analyses of the samples of different soils specially taken by me as typical of the various plant associations described herein and for contributing a most interesting chapter on the different types of soil found on the Flats.

To Charles M. Stewart Esq., B.Sc., Chief Meteorologist, Department of Irrigation, for kindly furnishing statistics of rainfall and temperatures at various stations on the Flats and on its borders.

To J. Lyall Soutter, Esq., F.R.Met.Soc., for a most valuable summary of the meteorological observations taken by him at Kopje Alleen in the

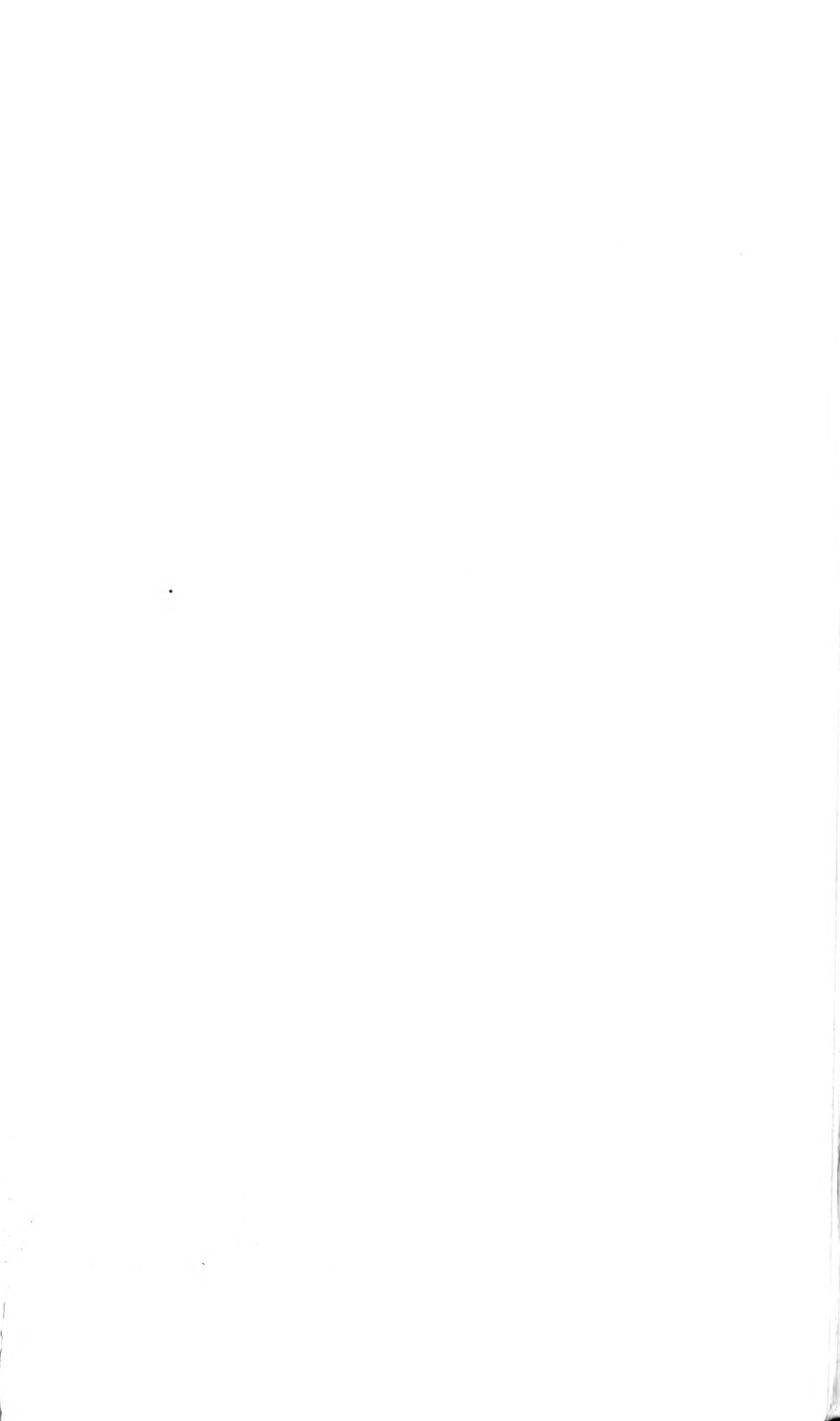
southern portion of the Flats. These are far more comprehensive than those of any other local station and with regard to many phenomena are the only local records that have been made.

To Captain G. Lyndoch Graham, D.F.C., of Weltevreden, Ypres Halt, for kindly supplying much valuable information regarding the suitability to local conditions and growth of many species of forest trees planted by him

E.E.G.

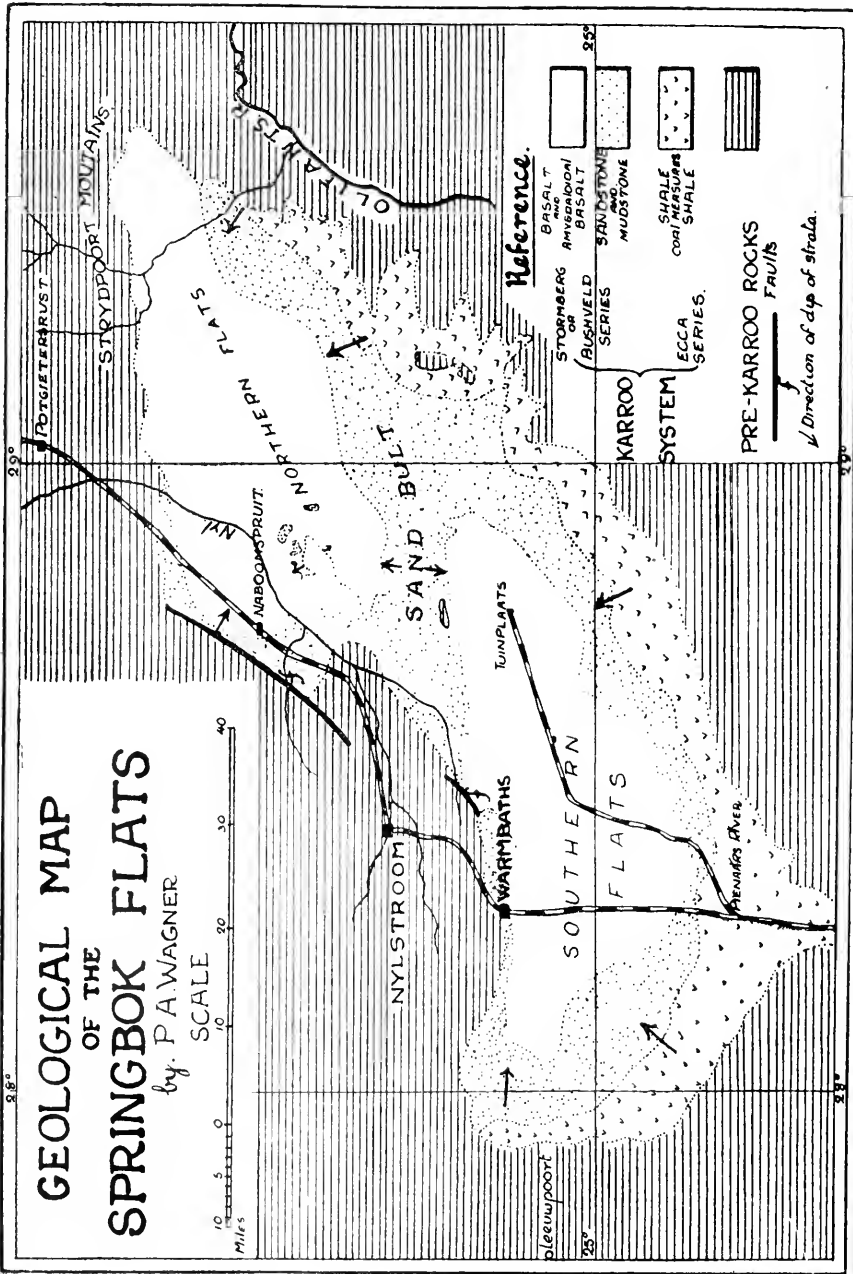
Mosdene,

P.O. Naboomspruit, 1926.



# GEOLOGICAL MAP OF THE SPRINGBOK FLATS

by PAWAGNER





# BOTANICAL SURVEY OF THE SPRINGBOK FLATS

TRANSVAAL.

## CLIMATE.

The climate is a very genial one with plenty of sunshine, both summer and winter, cool nights, good visibility, and no excessive heat. On the 18th and 19th October, 1920, a maximum temperature of  $100.2^{\circ}$  and  $100^{\circ}$ , Fahrenheit, in the screen, respectively, was registered at Mosdene. These are the only two occasions when  $100^{\circ}$  in the shade have been registered since records have been kept (six years).

Owing to the open nature of the country frosts are a good deal more severe than in the surrounding bushveld and there are usually one or two nights every winter when a temperature in the screen of  $7^{\circ}$  or  $8^{\circ}$  below freezing is recorded and occasionally more. The winter of 1919 was exceptionally cold and a temperature of  $12^{\circ}$  Fahrenheit ( $20^{\circ}$  below freezing) on the grass was registered at Mosdene. (This was before a screen was obtained.) Fig trees, eight feet high, were killed to the ground by the frost.

As a rule the first frost can be looked for about the 22nd May, and the last about the middle of August. On the 2nd September, 1924, however, there was a most untimely frost, six degrees below freezing being registered in the screen. This is the only occasion known on which there has been any frost at all in September.

Hailstones and gales are of very rare occurrence. The prevailing wind is from north to north-east and, unless sheltered by a wind-break, orchard trees have a tendency to lean in the opposite direction. There is usually sufficient daily wind to drive a windmill, and with moderate storage capacity and a good windmill, the wind can be depended upon to pump sufficient water from the boreholes, upon which residents on the flats are dependent, for domestic use and livestock, with the exception of two or three months in the autumn when there is little wind. During this period water can be provided for by the construction of a reservoir or dam sufficiently large to hold a few months' supply, which can be filled by wind power during the previous months, or hand-pumping or other power resorted to.

The following tables giving particulars of rainfall, temperature, etc., with the exception of those relating to Kopje Alleen and to Mosdene, have been kindly furnished by Mr. Chas. M. Stewart, B.Sc., Chief Meteorologist of the Union, from the official records.

The comprehensive tables relating to the Meteorological Station at Kopje Alleen have been very kindly placed at my disposal by the Observer, J. Lyall Soutter, Esq., F.R.Met.Soc., and furnish the most complete local meteorological data available. The farm, Kopje Alleen, is situated about ten miles north-east of Settlers Station.

Supplementary to these tables, Mr. Soutter has given me the following information and explanations:—

*Rainfall.*—The earlier records were started in February, 1913, by the late Major J. T. Mitchell (brother-in-law of Mr. Soutter) and carried on up to the end of 1919 by his widow on the eastern portion of Kopje Alleen.

known as "Deercroft" and marked "D" in the tables. From January, 1920, the figures used are those of Mr. Soutter's present station on the western portion of Kopje Alleen and are marked "KA" in the tables.

*Barometer Readings* were first made on 5th February, 1924, and with the exception of four days in May, 1924, and two days in May, 1925, the records are continuous to date.

*Dry Bulb, Wet Bulb and Maximum* were first read on 12th February, 1924, and with the exception of an odd day or two have been read regularly to date.

*The Minimum* was started on 2nd March, 1924, and the *Grass Minimum* on 25th March, 1924. Owing to the thermometer breaking no readings of the latter were taken between 26th May and 7th June, 1926.

*A Symons' Evaporation Tank*, 6 ft. x 6 ft. x 2 ft. was installed on 9th January, 1926, and it should be noted that the figures given for January are for the last 23 days of the month only.

*Depth of Water in Well.*—Measurements of depth of water were made twice a week from 4th April, 1924 to 22nd June, 1924, since which daily measurements have been made and the temperature of the water taken at the same time. There is a break of 14 days, in June, 1926, in the temperature records due to the thermometer breaking and having to be replaced.

*Level of Water in Bore Hole.*—On 23rd May, 1926. measurements of the water level in a bore-hole, which is at present unused, were commenced. At that date the distance from Ground Level (G.L.) to Water Level (W.L.) was 41 ft. 4.1 in. The water level has since continued falling fairly steadily till on 29th August, 1926 the distance from G.L. to W.L. had increased to 45 ft. 6.8 in. This bears eloquent testimony to the drought this season. The mean depth is 44 ft. 2.9 in.

*Records of Ground Frosts (30.4° and under):—*

1924—60 times—	First on	11th June (25.5°).	Last on	4th Sept. (27.4°).
1925—52	"	18th May (29.8°).	"	26th Aug. (28.4°).
1926—32	"	13th May (30.4°).	"	11th Aug. (27.0°).

*Records of Frost in Screen (32.0° and under):—*

1924—23 times.	First on	21st June (28.2°).	Last on	2nd Sept. (30.0°).
1925—12	"	21st May (31.0°).	"	21st July (31.9°).
1926—8	"	7th July (32.0°).	"	5th Aug. (31.8°).

Mr. Soutter's records show that gales and hailstorms are more frequent at Kopje Alleen than at Mosdene and the northern half of the Flats generally. During the 12 years that farming has been carried on at Mosdene there have been only three gales, each one blowing in a narrow belt across a different part of the farm, and during all that period only upon one occasion have any crops been injured by hail, viz., on the 28th January, 1921, when a hail storm swept across this portion of the Flats, in a narrow belt running from east to west, and destroyed a portion of the crops on Roodepoort and Zyferkraal.

The tables given for Mosdene (Roodepoort, No. 1004, eight miles south-east of Naboomspruit) are taken from my own records, the instruments used being supplied by the Office of the Chief Meteorologist. Unfortunately they only cover a short period, the rainfall records being from October, 1917, and the others from September, 1920. Observations over a longer period will probably somewhat modify the figures.

## TEMPERATURE AVERAGES AT NYLSTROOM.

Month.	Mean Maximum Temperature.	Mean Minimum Temperature.	Mean Temperature.
January .. .. .	84.3	60.3	72.3
February .. .. .	83.2	59.5	71.3
March .. .. .	80.6	56.3	68.4
April .. .. .	78.0	50.9	64.5
May .. .. .	74.5	42.7	58.6
June .. .. .	69.8	37.1	53.5
July .. .. .	69.0	36.1	52.5
August .. .. .	74.5	41.5	58.0
September .. .. .	80.6	48.4	64.5
October .. .. .	84.3	54.1	69.2
November .. .. .	83.2	56.6	69.9
December .. .. .	84.1	59.9	72.0

## AVERAGE RAINFALL.

Month.	Pienaar's Nek. Latitude 24.18. Longitude 29.20.	Mallow Farm. Latitude 24.56. Longitude 28.27.	Illawana. Latitude 24.58. Longitude 28.31.	Settlers. Latitude 24.58. Longitude 28.32.	Riekert's Vraag. Latitude 24.44. Longitude 28.47.	Mosdene. Latitude 24.35. Longitude 28.47.	Mosdene. Highest Recorded.	Mosdene. Lowest Recorded.
	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.
Jan. ..	5.82	5.91	6.33	4.97	4.81	5.20	8.57	2.04
Feb. ..	3.50	2.43	2.75	2.96	4.08	2.52	6.18	0.71
March ..	3.52	3.71	3.15	3.11	3.06	3.35	5.87	1.28
April ..	0.72	0.48	0.77	0.91	1.49	0.52	2.04	0.02
May ..	0.36	0.40	0.16	0.34	0.57	0.61	1.41	0.00
June ..	0.04	0.14	0.13	0.69	0.15	0.25	1.78	0.00
July ..	0.32	0.42	0.26	0.19	0.28	0.31	1.71	0.00
Aug. ..	0.22	0.91	0.81	0.56	0.32	0.24	2.06	0.00
Sept. ..	0.36	0.29	0.28	0.22	0.29	0.60	3.03	0.00
Oct. ..	2.06	1.98	1.79	1.71	2.27	2.25	4.97	0.79
Nov. ..	3.74	5.38	4.46	4.26	5.01	5.44	8.77	1.52
Dec. ..	4.87	4.68	4.36	4.44	4.23	2.87	4.51	1.53
Totals.	25.53	26.73	25.25	23.76	26.56	24.16	..	..

## METEOROLOGICAL RECORDS AT MOSDENE.

Month.	Year.	Mean of Dry Bulb Read- ings.	Mean of Wet Bulb Read- ings.	Mean maxi- mum Tem- pera- ture.	Mean mini- mum Tem- pera- ture.	Abso- lute maxi- mum Tem- pera- ture.	Abso- lute Mini- mum Tem- pera- ture.	Ap- proxi- mate Hours of Sun- shine.	Total Rain- fall in inches.
January ..	1918	..	..	..	..	..	..	..	8.57
	1919	..	..	..	..	..	..	..	4.67
	1920	..	..	..	..	..	..	..	5.53
	1921	70.9	64	83	60.7	93.7	56.4	262	5.59
	1922	74.3	65.7	88	61.5	94.8	52.4	337	3.00
	1923	71.1	65.7	82.3	62.4	91.4	58	250	6.75
	1924	74.1	64.3	88.1	61.6	96.8	53.9	319	3.29
	1925	70.6	64.4	81.3	60.6	88.6	52.9	278	5.66
	1926	75.5	67.7	89.8	63.4	96.8	56	279	2.04
Totals ..		436.5	391.8	512.5	370.2	562.1	329.6	1,725	45.10
Averages ..		72.7	65.3	85.4	61.7	93.6	54.9	287	5.2
February ..	1918	..	..	..	..	..	..	..	2.47
	1919	..	..	..	..	..	..	..	1.55
	1920	..	..	..	..	..	..	..	3.23
	1921	70.2	65.7	82.6	60.7	88.9	51	247	3.09
	1922	70.7	63.4	85.8	59	92.8	52.8	283	0.71
	1923	70.9	64.9	83	60	87.3	53.6	268	0.93
	1924	67.3	61.1	79.7	57.3	92.8	48	261	6.18
	1925	71.6	65.6	85.1	60.5	91.7	55.5	292	2.06
	1926	75.4	68.8	89.1	64.2	97	61.1	242	2.50
Totals ..		426.1	389.5	505.3	361.7	550.5	322	1,593	22.72
Averages ..		71	64.9	84.2	60.2	91.7	53.6	265	2.52
March ..	1918	..	..	..	..	..	..	..	5.87
	1919	..	..	..	..	..	..	..	3.15
	1920	..	..	..	..	..	..	..	3.27
	1921	69	64.5	81.2	58.1	89.6	50.1	..	4.13
	1922	68.8	62.6	84	57.8	90.6	51.3	280	2.10
	1923	69.2	63.4	82.2	57.8	87	47.9	290	1.28
	1924	68	64.2	78.6	60.8	88.3	54.3	171	4.60
	1925	68.3	64.9	80.2	60	87.1	47.4	139	3.27
	1926	71.9	63.5	84.9	59	93.3	49	282	2.54
Totals ..		415.2	383.1	491.1	353.5	535.9	300	1,162	30.21
Averages		69.2	63.8	81.8	58.9	89.3	50	193	3.35
April ..	1918	..	..	..	..	..	..	..	0.32
	1919	..	..	..	..	..	..	..	0.44
	1920	..	..	..	..	..	..	..	0.32
	1921	64.8	59.9	77.6	49.7	83.6	38.3	276	0.73
	1922	66.7	58.2	82.6	47.2	89.8	40.5	287	0.02
	1923	64	58.5	79.3	49.2	84.3	35.7	296	0.68
	1924	62.8	57.1	77.4	47.4	82.8	37.5	310	0.10
	1925	64.3	60.6	76.5	83.8	83	48	184	2.04
	1926	66.4	59.2	83.2	50.5	90.1	42	326	0.08
Totals ..		389	353.5	476.6	297.8	513.6	242	1,679	4.73
Averages		64.8	58.9	79.4	49.6	85.6	40.3	279	0.52

METEOROLOGICAL RECORDS AT MOSDENE—*Continued.*

Month.	Year.	Mean of Dry Bulb Read- ings.	Mean of Wet Bulb Read- ings.	Mean maxi- mum Tem- pera- ture.	Mean Mini- mum Tem- pera- ture.	Absol- ute maxi- mum Tem- pera- ture.	Absol- ute Mini- mum Tem- pera- ture.	Ap- prox- imate Hours of Sun- shine.	Total Rain- fall in inches.
May ..	1918	..	..	..	..	..	..	..	0.00
	1919	..	..	..	..	..	..	..	0.00
	1920	..	..	..	..	..	..	..	0.00
	1921	57.2	52.5	70.1	43	77.9	30	254	1.03
	1922	57.2	50.3	71.9	39.2	79.2	30	246	0.31
	1923	57.7	52.5	75	42.4	87.8	30.9	304	1.05
	1924	56.3	54	73.4	42.1	82.5	31.3	288	1.23
	1925	56.4	53.2	71.7	42.1	77.7	31.1	253	0.51
	1926	58.5	54	75.9	43.3	83.7	36.4	273	1.41
Totals ..		343.3	316.5	438	252.1	488.8	189.7	1,618	5.54
Averages		57.2	52.7	73	42	81.4	31.6	269	0.61
June ..	1918	..	..	..	..	..	..	..	0.00
	1919	..	..	..	..	..	..	..	0.00
	1920	..	..	..	..	..	..	..	0.00
	1921	54	46.7	72.6	35.6	79	28.9	294	0.00
	1922	51.2	47	72.1	34.4	81.4	21.8	292	0.45
	1923	51.4	46.2	70	34.1	78.8	27.5	289	0.03
	1924	50.5	46.1	70.3	32	77.5	23.5	292	0.00
	1925	51	46.6	71	34.2	80	25.2	278	1.78
	1926	52.7	49	71	38	80.6	30	288	0.06
Totals ..		310.8	281.6	427	208.3	477.3	156.9	1,733	2.32
Averages		51.8	46.9	71.1	34.7	79.5	26.1	288	0.25
July ..	1918	..	..	..	..	..	..	..	0.85
	1919	..	..	..	..	..	..	..	0.10
	1920	..	..	..	..	..	..	..	0.20
	1921	48.9	42.3	66.9	31.8	75.6	24	269	0.00
	1922	52.5	47.4	72.2	34	81	28	309	0.00
	1923	50.8	45.3	69.7	34.3	75.9	23.6	287	0.00
	1924	48.2	43.2	69.1	29.9	74.8	23.1	289	0.00
	1925	51.2	46.1	69.6	35.2	77.5	28.5	295	0.00
	1926	47.9	44.5	66	33.9	76	23.5	275	1.71
Totals ..		299.5	268.8	413.5	199.1	460.8	150.7	1,724	2.86
Averages		49.9	44.8	68.9	33.1	76.8	25.1	287	0.31
August ..	1918	..	..	..	..	..	..	..	0.00
	1919	..	..	..	..	..	..	..	0.00
	1920	..	..	..	..	..	..	..	0.00
	1921	55.4	47.2	74.5	35.5	82.4	27.6	313	0.00
	1922	57.9	52.4	76.8	42.1	88.6	31.2	289	2.06
	1923	58.9	52	77.7	40	89.3	31.2	308	0.00
	1924	56.5	50.5	74.7	38.9	87.3	32.3	315	0.12
	1925	58.2	50.8	77.8	38.2	85.8	30.4	332	0.00
	1926	58.1	51.5	77.4	39.9	89.8	24.5	335	0.00
Totals ..		345	304.4	458.9	234.6	523.2	177.2	1,892	2.18
Averages		57.5	50.7	76.4	39.1	87.2	29.5	315	0.24

METEOROLOGICAL RECORDS AT MOSDENE—*Continued.*

Month.	Year.	Mean of Dry Bulb Read- ings.	Mean of Wet Bulb Read- ings.	Mean maxi- mum Tem- pera- ture.	Mean Mini- mum Tem- pera- ture.	Abso- lute maxi- mum Tem- pera- ture.	Abso- lute Mini- mum Tem- pera- ture.	Ap- proxi- mate Hours of Sun- shine.	Total Rain- fall in inches.
September	1918	..	..	..	..	..	..	..	1.00
	1919	..	..	..	..	..	..	..	0.00
	1920	67.1	59.3	84.9	50.5	92.8	44.5	304	0.00
	1921	64.5	53.7	79.9	45.6	93.6	35.2	298	0.06
	1922	65.5	56.9	80.5	48.6	90.1	39.9	304	0.25
	1923	67.3	57.1	83.7	47.5	98	38.3	310	0.21
	1924	63.8	57	80.3	47	93	26	302	0.64
	1925	62.9	55.3	77.7	47.5	91.8	38.3	259	3.03
	1926	65.1	59.4	82.6	48.6	96	36.1	240	0.24
Totals ..		456.2	398.7	569.6	335.3	655.3	258.3	2,017	5.43
Averages		65.1	56.9	81.3	47.9	93.6	36.9	288	0.60
October ..	1917	..	..	..	..	..	..	..	0.79
	1918	..	..	..	..	..	..	..	0.86
	1919	..	..	..	..	..	..	..	1.58
	1920	69.1	63.2	83.3	54.7	100.2	39.9	231	4.97
	1921	70.3	62.6	84.6	56.3	95.9	46.2	244	4.27
	1922	69.1	61.7	82.8	55.5	94.2	42.2	301	3.27
	1923	73.9	63.1	89.8	56.4	97.9	43	326	2.30
	1924	70.3	62.6	84.6	55.4	92.8	48.1	284	1.37
	1925	70	59.3	83.8	52.9	94.4	45.4	314	0.84
Totals ..		422.7	372.5	508.9	331.2	575.4	264.8	1,700	20.25
Averages		70.4	62	84.8	55.2	95.9	44.1	283	2.25
November	1917	..	..	..	..	..	..	..	6.96
	1918	..	..	..	..	..	..	..	1.52
	1919	..	..	..	..	..	..	..	8.77
	1920	72.8	65.1	85.2	59.7	95.6	50.5	284	5.30
	1921	68.5	61.3	79.6	57.9	94.2	44.1	173	7.65
	1922	71	62.8	83.9	58.6	94.7	49.1	303	3.29
	1923	73.1	65.6	86.7	61.8	99	54.7	269	3.55
	1924	70	63.8	82.7	58.7	97	49.2	243	7.19
	1925	72.8	63.4	86.2	57.6	95.5	48.2	280	4.78
Totals ..		428.2	382	504.3	354.3	576	295.8	1,552	49.01
Averages		71.3	63.3	84	59	96	49.3	258	5.44
December	1917	..	..	..	..	..	..	..	4.51
	1918	..	..	..	..	..	..	..	2.38
	1919	..	..	..	..	..	..	..	2.93
	1920	71.6	62.7	85.7	59.5	93.1	52.8	262	2.16
	1921	70.4	63.3	83.3	59.5	93.5	53.8	280	3.30
	1922	73.7	64.2	86.6	61	96.7	52.7	284	2.80
	1923	71.4	64.1	84.2	60.2	94	52.5	293	2.63
	1924	69.2	59.4	80	60.6	87	55.9	287	3.62
	1925	77.4	66	91.1	62.8	99.8	52.8	312	1.53
Totals ..		433.7	379.7	510.9	363.6	564.1	320.5	1,718	25.86
Averages		72.2	63.2	85.1	60.6	94	53.4	286	2.87

## SUPPLEMENT.

METEOROLOGICAL RECORDS AT MOSDENE FROM OCTOBER, 1923,  
TO DECEMBER, 1927.

Month.	Year.	Mean of Dry Bulb Readings.	Mean of Wet Bulb Readings.	Mean Maximum Temperature.	Mean Minimum Temperature.	Absolute Maximum Temperature.	Absolute Minimum Temperature.	Approximate Hours of Sunshine.	Total Rainfall in inches.
October .. ..	1926	71.3	58.3	88.5	55.2	96.5	43.1	330	0.36
November .. ..	..	70.9	63.1	86.8	59.5	99.5	52.6	256	3.74
December .. ..	..	73	65.7	86.4	61.4	94.4	56.4	303	2.76
January .. ..	1927	73.3	66.2	89.1	63.8	99.4	50	263	3.18
February .. ..	..	72	63.7	86.2	60	93.5	53.1	279	4.64
March .. ..	..	68	62.2	81.7	57	88.5	51.8	247	3.37
April .. ..	..	65.2	59.7	79.3	51.2	85.3	41.6	280	0.93
May .. ..	..	58.3	50.7	76.1	39.1	82.5	29	312	0.00
June .. ..	..	54.5	46.2	70.1	33.5	77.1	30	279	0.00
July .. ..	..	50.8	47.1	70.1	36.8	78.1	28	271	0.62
August .. ..	..	55.4	47.9	73.2	39.7	84	28.7	320	0.70
September .. ..	..	66.7	55.5	85.6	47.9	94.2	40.3	329	0.28
October .. ..	..	70.7	59.8	84.9	55.9	97	47	237	1.94
November .. ..	..	74	62.8	88.3	60.3	101.2	49	295	1.17
December .. ..	..	73.7	64.1	88.5	62.5	96.1	58.8	255	3.47





METEOROLOGICAL OBSERVATIONS AT W. PORT. KOPJE ALLEEN NO. 1092, DIST. WATERBERG. J. LYALL SOUTTER, F.R. MET.SOC., OBSERVER, 1-9-26.

	Barometer (Inches) Corrected for Temperature and Gravity.					TEMPERATURES (FAHR.)																									Evapor. Symons Tank	Depth of Water in Well									
						Maximum.					Minimum.					Mean.	Mean.	Grass Minimum.					At 8 h. 30 m.					Water in Well at 8 h. 30 m.						Water in Evap. Tank at 8 h. 30 m.							
	Highest	Date	Lowest	Date	Mean	Highest	Date	Lowest	Date	Mean	Lowest	Date	Highest	Date	Mean			Lowest	Date	Highest	Date	Mean	Highest	Date	Lowest	Date	Mean	Highest	Date	Lowest	Date	Mean	Highest	Date	Lowest	Date	Mean	Total	Mean		
1924	26.4		26.4		26.4	°		°		°	°		°		°	°	°		°		°	°		°		°	°	°	°	°	°	°	°	°	°	°	°	°	Inch.	ft. in.	
January ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
February ..	674	18	277	11	520	93.1	27	70.4	12	81.7	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
March ..	686	31	347	9	523	90.0	23	63.2	30	79.5	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
April ..	722	27	483	17	604	84.9	13	68.1	21	78.3	41.3	29	54.7	11	48.7	63.5	29.6	35.8	29	53.4	11	44.6	71.0	13	57.6	23	63.5	..	..	..	..	..	..	..	..	..	..	..	..	..	..
May ..	720	14	297	20	587	84.1	11	66.2	20	74.2	32.9	25	52.7	1	44.5	59.4	29.7	32.0	26	48.4	1	40.5	65.1	11	48.6	8	57.3	..	..	..	..	..	..	..	..	..	..	..	..	..	..
June ..	922	21	493	10	666	77.3	10	60.3	25	69.5	27.9	22	42.1	8	34.8	52.2	34.7	20.6	30	37.5	8	29.0	58.0	2	43.8	26	50.1	69.0	24/25	66.0	28	67.9	..	..	..	..	..	..	..	..	17 7.2
July ..	913	14	546	22	701	75.5	18	63.1	28	69.2	27.2	20	42.3	27	32.6	50.9	36.6	19.9	18	39.3	27	22.4	55.4	30	42.9	9	49.1	71.7	12	63.7	3	70.1	..	..	..	..	..	..	..	..	17 2.7
August ..	846	13	476	31	647	87.4	28	65.2	12	74.7	32.7	3	48.3	29	39.8	57.3	34.9	26.0	9	43.9	17	32.9	65.6	24	46.3	7	55.8	71.7	28	70.0	5/11/21	70.7	..	..	..	..	..	..	..	..	17 9.3
September ..	758	2	420	26	582	93.6	21	56.8	24	80.6	30.0	2	62.1	22	47.2	63.9	33.4	27.4	4	60.4	22	44.1	79.7	21	45.2	1	62.9	72.1	22/23	70.8	2	71.4	..	..	..	..	..	..	..	..	17 9.6
October ..	667	28	284	15	510	92.2	31	74.8	21	85.2	47.2	10	62.7	25/31	55.8	70.5	29.4	39.2	8	60.1	31	52.0	79.8	24	61.2	9	70.2	72.1	1/2/4	71.0	7	71.8	..	..	..	..	..	..	..	..	17 1.4
November ..	604	10	382	14	496	94.3	24	65.2	4	82.5	50.3	8	65.7	3	58.5	70.5	24.0	43.9	8	63.7	3	55.8	82.4	24	58.4	9	70.1	73.0	26	71.5	9	72.1	..	..	..	..	..	..	..	..	16 8.1
December ..	589	13	323	20	474	91.0	30	69.1	11	80.9	56.3	14	65.3	31	60.7	70.8	20.2	51.2	14	62.9	16	58.1	79.4	20	63.8	7	70.1	72.7	31	71.5	16	72.0	..	..	..	..	..	..	..	..	15 8.9
Means and Extremes	922	21/6	277	11/2	574	94.3	24/11	56.8	24/9	77.8	27.2	20/7	65.7	3/11	47.0	52.1	30.2	19.9	18/7	63.7	3/11	42.2	82.4	24/11	42.9	9/7	62.3	73.0	26/11	63.7	3/7	70.9	..	..	..	..	..	..	..	..	16 7.7
1925																																									
January ..	575	18	238	14	423	91.9	27	68.6	15	83.7	52.3	19	66.0	3	60.8	73.3	22.9	47.8	19	64.4	14	57.9	78.0	27	60.7	16	71.6	73.0	30/31	72.0	16/17/28	72.4	..	..	..	..	..	..	..	..	14 3.1
February ..	647	23	362	5	499	92.1	16	76.5	21	86.7	55.9	6	64.8	16	61.2	73.9	25.5	50.7	6	63.7	10	57.8	78.3	16	65.9	10	72.8	73.0	14	72.8	10/13	72.9	..	..	..	..	..	..	..	..	14 1.6
March ..	641	4	251	16	466	87.6	6	70.8	25	79.4	50.2	31	66.2	22	61.2	70.3	18.2	45.2	31	65.6	22	58.8	74.7	9	60.4	31	68.7	73.0	15/23	72.0	3/31	72.6	..	..	..	..	..	..	..	..	13 11.1
April ..	712	11	481	24	574	83.7	17	62.2	26	75.2	50.2	20	61.2	10	54.4	64.8	20.8	44.3	24	58.7	10	51.6	69.7	23	56.7	27	64.1	72.7	17/19	71.8	15	72.2	..	..	..	..	..	..	..	..	15 9.0
May ..	746	19	368	7	578	76.7	28	63.6	30	69.8	31.0	21	58.3	4	44.4	57.1	25.4	28.5	20	58.1	4	38.9	65.6	1	46.0	20	54.6	71.9	4/5/6	68.2	22	70.2	..	..	..	..	..	..	..	..	17 1.4
June ..	849	30	461	19	617	78.8	3	51.0	22	68.9	28.5	10	50.1	22	36.1	52.5	32.8	20.4	15	49.2	22	29.1	58.8	4	43.2	5	50.0	70.6	1	67.2	25	69.1	..	..	..	..	..	..	..	..	17 8.2
July ..	875	30	480	14	698	75.5	25	61.7	20	68.1	30.6	1	44.3	15	36.9	52.5	31.2	24.2	21	40.3	15	30.1	59.9	14	44.6	16	49.9	72.2	15	67.1	23	69.3	..	..	..	..	..	..	..	..	17 7.4
August ..	826	1	471	12	695	83.8	31	69.0	12	76.1	33.6	2	47.6	12	40.2	58.2	35.9	24.9	2	39.3	18	32.0	65.2	18	48.8	13	57.7	70.9	21	69.0	3	69.9	..	..	..	..	..	..	..	..	17 6.2
September ..	878	17	392	13	588	90.1	30	60.9	14	76.2	41.3	19	57.6	30	47.9	62.1	28.3	31.6	18	54.0	14	41.6	77.4	29	52.2	24	62.1	71.3	15	69.0	26	70.5	..	..	..	..	..	..	..	..	16 4.6
October ..	665	1	351	8	532	94.1	29	71.9	6	83.6	44.7	9	62.9	16	53.4	68.5	30.2	39.1	9	56.1	4	47.1	79.2	30	61.9	10	68.8	72.8	31	71.2	2	71.9	..	..	..	..	..	..	..	..	15 7.2
November ..	643	6	346	28	495	95.2	21/23	73.1	13	86.0	47.4	29	63.8	25	58.0	72.0	28.0	40.0	29	62.6	25	53.4	84.4	21	59.7	4	71.6	73.1	3	72.1	29	72.7	..	..	..	..	..	..	..	..	14 10.8
December ..	603	10	315	13	487	98.0	21	74.5	8	89.8	55.1	1	69.0	21	63.1	76.5	26.7	47.8	14	65.7	6	58.9	85.1	21	64.7	10	76.3	72.9	21/22	72.1	1/3/4	72.5	..	..	..	..	..	..	..	..	14 6.8
Means and Extremes	878	17/9	238	14/1	554	98.0	21/12	51.0	22/6	78.6	28.5	10/6	69.0	21/12																											



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Year	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098	2099
Population	31.95	84	24.03	72	22.01	55	28.40	83	29.05	92																																																																																															

Average 26.24 68





	Vapour Pressure, 8 h. 30 m. Mean.	Dew Point. 8 h. 30 m. Mean.	Rel Hum. 8 h. 30 m. Mean.	Thunderstorms.	Hall.	Gale.	Cloud Amount.					Wind : No. of Observations 8 h. 30 m.																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
							No. of Observations 8 h. 30 m.					Force (0—12).				Direction.																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					
							Mean.	0 to 3	4 to 6	7 to 9	10	Mean.	8 or over	4 to 7	1 to 3	Calm.	N.	N.E.	E.	S.	W.	N.W.																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
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Kopje Alleen	Temperatures at 8.30																Total Evapo- ration. Ins.	Mean Depth of Water in Well	Mean Ground Level to Water Level in Bore- hole	Cloud amount at 8.30						Wind : No. of Observations at 8.30														Rainfall							
	Water in Well					Water in Borehole					Water in Evaporation Tank									No. of Observations						Force						Direction								R.G. at House.				R.G. at Lands			
	Highest	Date	Lowest	Date	Mean	Highest	Date	Lowest	Date	Mean	Highest	Date	Lowest	Date	Mean	Mean				0	1 to 3	4 to 6	7 to 9	10	Mean	8 and over	4 to 7	1 to 3	Calm	N	NE	E	SE	S	SW	W	NW	Total	No. of Days	Greatest fall in 1 day	Date	Total	No. of Days	Greatest fall in 1 day	Dat		
1926.	°		°		°	°		°		°	°		°		°																																
Sept. ..	73.0	16, 25, 28	71.1	8	72.0	73.0	12, 19, 26	73.0	12, 19, 26	73.0	65.0	26, 27	51.7	4	58.3	6.88	8 11.1	45 9.2	2.4	18	5	0	4	3	3.6	0	16	14	0	8	10	4	1	0	2	2	3	0.23	1	0.23	25	0.22	1	0.22	25		
Oct. ..	73.1	26, 27, 31	71.3	11	72.4	73.1	24, 31	73.0	10, 17	73.0	72.0	30	58.0	6	64.1	9.96	8 10.4	46 0.7	3.1	15	3	6	4	3	4.1	0	24	4	0	5	12	0	1	2	3	0	5	0.22	5	0.09	27	0.19	5	0.08	27		
Nov. ..	73.5	12	72.5	30	73.2	73.1	4, 14	72.9	21	73.0	70.7	1	62.7	5	66.5	9.46	8 2.8	46 8.0	4.6	2	11	8	6	3	3.9	0	21	9	0	7	14	1	2	1	0	1	4	3.26	10	1.26	25	3.35	10	1.23	25		
Dec. ..	74.0	7, 10	72.0	13	73.1	73.0	19, 26	72.9	5	73.0	77.0	15	62.3	7	67.3	8.34	7 11.9	47 4.3	4.1	5	12	6	3	5	3.4	0	19	12	0	10	11	0	2	1	1	2	4	5.17	12	1.85	6	4.81	10	1.42	6		
Totals ..	..	6/7	..	..	..	..	..	..	..	..	..	..	..	..	..	76.44	..	..	..	132	97	61	55	20	..	0	154	207	1	72	19	22	12	27	30	31	38	19.57	71	..	..	19.60	68	..	..		
Means and Extremes	74.0	7/10/12	69.8	11/7	72.5	73.1	24/31/10 4/14/11	71.7	29/8	72.9	77.1	5/2	40.8	23/7	61.2	6.37	10 6.9	44 2.9	3.1	...	...	...	...	...	3.1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1.85	6/12	...	...	1.77	4/5		
1927.																																															
Jan. ..	73.6	23	73.0	10 times	73.2	73.5	23	72.8	9	73.2	77.5	25	68.2	9	72.6	8.12	7 7.0	47 7.8	4.4	7	8	5	8	3	3.3	0	17	14	0	10	14	3	0	1	0	1	2	3.73	14	1.31	2	3.84	13	1.40	2		
Feb. ..	74.0	15	73.0	times	73.2	73.3	6	73.0	13, 20, 27	73.1	73.0	2	67.8	7	70.4	7.43	7 3.2	48 3.5	4.3	7	7	5	6	3	3.2	0	12	16	0	8	7	3	1	3	0	2	4	4.04	11	1.50	26	4.10	10	1.31	26		
Mar. ..	73.3	28, 30	72.1	9	72.9	73.1	13	72.9	5	73.0	72.6	15	66.0	21	69.4	5.27	7 0.3	48 3.5	3.5	9	8	6	5	3	3.0	0	13	18	0	7	14	4	1	2	2	0	1	1.04	9	0.49	1	0.97	7	0.50	1		
April ..	73.1	2 to 5 4, 7,	72.2	23, 24	72.8	73.0	17, 24	72.9	10	73.0	69.1	1	58.2	29	64.4	4.71	6 8.7	48 4.0	2.9	7	13	4	6	0	2.5	0	8	22	0	5	15	3	0	2	2	2	1	2.04	5	0.87	2	2.04	5	1.01	3		
May ..	73.0	12	70.1	19	71.8	73.0	..	73.0	..	73.0	59.9	3	45.7	15	52.9	4.42	6 5.8	48 8.1	1.1	19	9	1	2	0	2.2	0	6	25	0	6	4	2	0	5	5	7	2	0.46	1	0.46	7	0.12	1	0.12	7		
June ..	70.3	16, 17	63.0	25	68.4	73.0	..	73.0	..	73.0	53.3	1	45.4	16	47.9	3.09	5 4.1	50 5.5	1.6	18	7	1	4	0	1.6	0	0	30	0	5	3	2	0	2	3	12	3	..	..	..	..	..	..	..	..		
July ..	72.8	25, 26	67.0	4	70.2	73.0	..	73.0	..	73.0	55.2	30	44.8	16	49.3	3.54	5 5.1	50 4.8	1.9	18	6	3	3	1	1.9	0	4	25	2	13	3	1	3	4	2	2	1	0.60	3	0.53	25	0.56	2	0.49	25		
August ..	72.0	2	67.0	29	70.3	73.0	..	73.0	..	73.0	56.3	24	47.5	27	53.0	4.84	5 5.3	50 8.3	1.8	18	7	2	3	1	2.5	0	6	25	0	6	4	4	2	7	3	3	2	0.14	1	0.14	7	0.14	1	0.14	7		
Sept. ..	72.0	17, 18	67.7	1, 2	70.2	73.2	11	73.0	..	73.1	65.2	30	53.2	1	60.8	7.50	5 1.9	51 1.8	1.0	19	9	1	0	1	3.5	0	17	13	0	14	7	2	0	0	2	2	3	0.10	2	0.07	16	0.11	2	0.07	16		
October..	72.6	27 7, 8,	71.0	..	71.7	73.2	..	73.0	..	73.1	69.0	26	60.3	20	65.0	8.31	4 9.9	51 7.1	4.1	11	5	4	8	3	3.5	0	21	10	0	16	8	3	1	0	1	1	1	5.42	8	3.25	26	3.91	8	1.89	26		
Nov. ..	72.0	12, 16	70.7	18 to 20	71.4	73.3	6	73.0	20	73.1	74.3	28	64.8	20	70.0	8.99	4 9.2	51 1.2	3.9	4	12	7	6	1	3.1	0	12	17	1	10	7	2	1	0	3	1	5	1.80	8	1.42	24	1.56	7	1.22	24		
Dec. ..	72.0	3	70.9	13, 14	71.4	73.2	25	73.1	..	73.1	74.8	26	68.2	22	71.8	8.26	4 7.9	51 2.7	5.5	0	12	3	13	3	2.7	0	10	21	0	10	6	1	2	0	2	2	8	3.75	14	1.30	15	4.00	13	1.47	15		
Totals ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	74.48	..	..	..	137	103	42	64	19	..	0	126	236	3	110	92	30	11	26	25	35	33	23.12	76	..	..	21.35	69	..	..		
Means and Extremes	74.0	15.2	63.0	25/6	71.5	73.5	23/1	72.8	9/1	73.1	77.5	25/1	44.8	16/7	62.3	6.21	5 10.7	49 10.7	3.0	..	..	..	..	..	2.75	..	..	..	..	..	..	..	..	..	..	..	..	..	..	3.25	26/10	..	..	1.89	26/10		

Hail	Thun- der storms	Gale 8 or over	Screen Frost		Ground Frost	
			32° and under		30° 4 and under	
			No.	First and Last	No.	First and Last
0	2	2	0	0	0	0
0	9	1	0	0	0	0
0	15	3	0	0	0	0
0	6	0	0	0	0	0
4	92	8	8	First 7 7/26 Last 9 8/26	32	First 13 5/26 Last 11 8/26
..	14	1	..	..	..	..
..	11	..	..	..	..	..
1	10	..	..	..	..	..
..	5	..	..	..	..	..
..	..	..	..	..	7	First 14
..	..	..	..	..	21	..
..	1	..	2	First 20 Last 27	11	.. last 30
..	3	..	1	..	5	..
..	5	2	..	..	..	..
..	12	..	..	..	..	..
..	11	..	..	..	..	..
..	21	..	..	..	..	..
1	93	3	3	First 20/7 Last 27/8	44	First 14/5 Last 30/8
..	..	..	..	..	..	..



## TOPOGRAPHY.

The Springbok Flats are situate in the Northern Transvaal, mainly in the districts of Waterberg and Potgietersrust and extending on the south for a short distance into the Pretoria district. They form an irregular oblong figure about 130 miles long and 30 to 40 miles wide, extending from longitude E.  $27^{\circ} 55'$  to E.  $29^{\circ} 32'$  and from latitude S.  $24^{\circ} 18'$  to S.  $25^{\circ} 25'$ , the longer axis taking a north-easterly direction.

For further details reference should be made to Dr. P. A. Wagner's very valuable and full account of the geology of the Flats, in which its topography is also dealt with, and to his accompanying map.

To these, I desire to add the following description of its water system, as of interest to the botanical survey and not dealt with by Dr. Wagner in detail.

The Nyl River traverses the western border of the Flats for about 55 miles, from Waterberg Siding to Moorddrift. The average fall of the river between Nylstroom Station and the Railway bridge near Moorddrift is only six feet a mile (*vide* Report E. H. Hughes referred to later on) and for the greater part of its course over the flats it has a very small and ill-defined channel, meandering through a broad grassy vlei, which is nearly two miles wide in the neighbourhood of Naboomspruit. The greater part of this vlei usually becomes a marsh towards the end of the rainy months and gradually dries up during the autumn and winter, remaining dry till flooded again by the rains of the following season. Large quantities of water brought down from the mountains in the west, where the rainfall is much heavier than on the Flats, by the Great and Little Nyl rivers, Olifants' spruit, Badzynloop, Tobiasloop, Rietbokspruit and Coetzeesloop pour into this vlei, of which the greater amount disappears underground, leaving a very small portion to flow down the Nyl river after it leaves the Flats at Moorddrift and once more flows in a defined channel.

In October, 1921, at the end of the dry season when the water is at its lowest, at the request of the Eastern Waterberg Farmers' Association, Mr. E. H. Hughes, Circle Engineer, Irrigation Department, made an investigation of the irrigation possibilities of the Nyl river and found that whilst at Deel Kraal, near Boekenhout Siding, at the time of his visit the river was flowing at about two cusecs, nine miles lower down, at du Toitskraal, the flow was reduced to less than half a cusec, whilst a little further down from Zandpan to Vaalkop, the river was quite dry. This, notwithstanding the fact that the flow at Deelkraal was reinforced by further streams flowing into it from the Badzynloop and other tributaries along its course and that no water is led out of it for irrigation or other purposes.

Mr. Hughes reported that the normal flow was insufficient to warrant any extensive irrigation works and that conservation dams, to hold the immense quantities of water brought down during the summer rains, were impracticable, owing to the very flat nature of the Nyl valley not affording any suitable sites for their construction. He further reported that, given a sufficiency of water, there would be no difficulty in leading it out of the Nyl river by gravitation over the whole Flats, which slope gradually to the east, the level at P.O. Roedtan, 26 miles east of Naboomspruit, being about seventy feet lower than that of the Nyl at Zandpan.

There are further strong streams of water brought down from the Strydpoort mountains in the north by the Groothoek, Magoto and Gompies rivers which flow on to the Flats and there also disappear.

With the exception of some half dozen small springs dotted about, which form small water courses during the wet season that disappear after running a mile or two at most, there are no surface waters on the Flats inside of the rivers already mentioned as flowing along its margins. Added to this, owing to the very level nature of the country there is little run-off and a great absence of suitable sites for the construction of reservoirs. This is a distinct drawback but the level country presents so many other advantages in freedom from erosion, in absorbing in deep soil every drop of rain that falls and in facilities for easy cultivation as to compensate many times over. The great abundance of its underground water supply is also due to these conditions aided by favourable rock conformation. Underground water can be tapped in large quantity at anything from 20 to 80 ft. below the surface on every farm and is, with one or two negligible exceptions, of the best quality. This very regular yield of subterranean water in considerable quantity over so large an area is probably due not only to the soaking in and collection of practically all the rain falling on the Flats, but also to the seepage from the Nyl and other streams mentioned whose waters come from a higher level and disappear underground after flowing on to the Flats.

The above remarks do not refer to the narrow belt fringing the eastern and south-eastern borders where the character of the country changes and owing to the absence of and difficulty in obtaining borehole water is in great part fit only for cattle ranches. This portion, in which the lower strata of the Karroo System either outcrop or approach the surface is not looked upon from a farming point of view as forming a part of the Springbok Flats proper and is not dealt with in my survey.

## THE GEOLOGY OF THE SPRINGBOK FLATS.

BY PERCY A. WAGNER, D.Sc., D.Eng., F.G.S.

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## INTRODUCTION.

The area popularly known as the Springbok Flats consists physiographically and geologically of three main elements, namely—

- (1) The Northern Flats, a broad expanse of apparently level, open grass-land and tree-steppe extending from the neighbourhood of Naboomspruit to the foot of the Strydpoort Mountains.
- (2) The Southern Flats, a similar tract occupying an irregular elongated area some 57 miles in length and up to 20 miles in breadth, to the south of Warmbaths.
- (3) The so-called Sand Belts separating the Northern and Southern Flats and bordering the latter on the west, south and east. A lesser sand-belt also projects north-eastward into the Northern Flats. The sand-belts are broad swelling sandy ridges or *bults*, covered with trees and scrub. They attain elevations of from 50 to 160 ft. above the level of the adjacent plains, which range from 3,400 to 3,700 ft.

A fourth physiographic element of great interest, with which, however, we need not here concern ourselves, is the valley of the Nyl which intersects the western part of the Northern Flats.

The geological structure of the area is comparatively simple. It is occupied entirely by sedimentary and igneous rocks belonging to the Karroo System, which fill a tectonic basin of irregular oval outline extending from longitude E. 27° 55' to longitude E. 29° 32'. and from latitude S. 24° 18' to latitude S. 25° 25'. The longer axis of the basin trends north-east—south-west.

The Northern and Southern Flats mark the position of two minor basins within this main basin, occupied by basaltic lavas belonging to the Drakensberg or Volcanic Series of the Karroo System: while the sand belt

mark the position of the outcrops of the underlying sandstones of the Bushveld Sandstone Series. Along the south-western, southern and eastern margins of the Springbok Flats the sandstones and mudstones are underlain unconformably by shales, coal measures and sandstones belonging to the Ecca Series, the lowest member of the Karroo System represented in the area under review. The Karroo rocks rest on an uneven floor composed of older rocks belonging to the Transvaal and Waterberg Systems and to the Igneous Complex of the Bushveld. These rocks rim the main basin and in places project island-like from the younger Karroo beds.

The distribution of the several formations above referred to, is shown on the accompanying geological map (*see* Frontispiece), which also gives a good idea of the physiography of the area, there being an exceedingly close relation between the physical features and geology of this part of the Transvaal. It should be stated that in their northern part the Flats have a general easterly slope towards the valley of the Olifants River, while in their southern part the general slope of the surface is south-eastward, toward the valley of the Elands River. The geological formations may be classified as follows in descending order. Wavy lines denote unconformities.

## 2. TABLE OF GEOLOGICAL FORMATIONS.

Recent and Superficial Deposits	{	Sands, " Ouklip " or surface ironstone, calcareous tufa, black, red, brown, grey and chocolate coloured soils.	
Alluvial Deposits .. ..		Sands and gravels of the Nyl Valley.	
Karoo System	{	Stormberg or Bushveld Series	{ Volcanic Series. Basalt and amygdaloidal basalt. Bushveld Sandstone Series. Sandstone, mudstone, sandy shale.
		{ Ecca Series	Upper Ecca. Shales, calcareous shales, thin limestone.
	Coal Measure Series. Coal, shales, grits, sandstones.		
	Lower Ecca. Shales.		
	Pre-Karoo Rocks	Waterberg System	
Igneous Complex of the Bushveld		Red granite, granophyre, felsite.	
{ Transvaal System		Pretoria Series	Quartzite, shale, arkose.
		Dolomite Series	Dolomite.

Along the southern and south-eastern margins of the Flats there is a regular succession from pre-Karoo rocks through the shales and coal measures of the Ecca Series to the sandstones and basalts of the Stormberg Series. Proceeding north-eastward there is a progressive overlap of the older members of the Karroo System by the younger.

Thus the deep borehole on the farm Ludlow, No. 2355, situated 14 miles east-south-east of Warmbaths shows a very considerable thickness of basalt and sandstone underlain by 185 feet of red, purplish, yellow and green mudstones in which the hole was stopped; whereas the borehole on the farm Diepsloot, No. 1738, situated 3 miles north of Tuinplaats Station shows an almost equally great thickness of basalt and sandstone resting directly on hard white quartzite probably belonging to the Pretoria Series.

Along the north-eastern margin of the Northern Flats the Bushveld Sandstone is in turn overlapped by the basalts which abut directly on the pre-Karoo rocks building the Strydpoort Mountains and the range to the

west of them. This north-eastward overlap may be due to a progressive subsidence toward the north-east of the rocks flooring the main basin while the several members of the Karroo System were being laid down. The folding of the main basin into the two minor basins already referred to probably occurred during the latter part of the period represented by these rocks. It was accompanied by minor folding of which there is evidence along the northern edge of the Southern Flats. These crustal movements were evidently the cause of the faulting along the north-western and western margins respectively of both the Northern and Southern Flats. Reference to the accompanying map will show that in these directions the contact between the Karroo and pre-Karoo rocks is over considerable distances a faulted one. This faulting is probably also partly responsible for the remarkable features displayed by the Nyl Valley south of Moorddrift. That it is still in progress is evidenced by the occasional earthquakes experienced in the Warmbaths-Nylstroom area. Hot springs issue along several of the faults proving that the fault fissures descend to great depths. The remarkable platinum deposits opened up on the farms Rietfontein, No. 3, and Welgevonden, No. 1772, situated 12 miles west-north-west of Naboomspruit, occupy faults related to those shown on the map.

### 3. THE KARROO SYSTEM.

It is with the rocks of the Karroo System, and particularly with those belonging to the Stormberg Series, that we are particularly concerned. It will be useful, however, also to treat briefly of the Ecce Series.

#### *The Ecce Series.*

This is of economic importance owing to the occurrence in it of seams of workable coal. Coal has actually been struck in a number of boreholes along the south-western, southern and eastern margins of the Flats; thus on Vangheining, No. 1724, situated 20 miles south-west of Warmbaths, near Pienaars River Station, on Middelkopjes, No. 365, situated 13 miles north-east of Pienaars River, on Troya, No. 603, adjoining Schildpadfontein, on Marffin, No. 1869, situated on the eastern edge of the Northern Flats, and a number of other farms.\* We have thus evidently to do here with quite an extensive coal-field. The coal is of fair quality and the seams are of workable width. As it is far less favourably situated, however, with regard to the principal centres of consumption than the Witbank, Brakpan and Southern Transvaal fields, which also yield much better coal, there is little prospect of its being worked in the near future.

The coal seams are associated with sandstones, grits, and shales, which give rise to the monotonous flat scrub-covered country about Pienaars River and to the east and west of the Southern Flats. The surface of the area which they underlie is covered with reddish-brown sandy soil interspersed with patches of black soil in the vleis. The commonest trees on the Flats in the neighbourhood of Pienaars River Station are *Acacia karroo* and *Dichrostachys nutans*, with *Combretum erythrophyllum* along the river itself.

Along the southern and south-eastern margins of the Flats the coal measures are underlain and overlain by blue-grey, grey and brownish shales. These rocks never outcrop and their presence was established by Dr. A. L. du Toit as a result of boring operations. The Lower Ecce shales and the thin sandstones intercalated with them give rise to brownish-red sandy

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\*Recently coal has also been struck on the farm Het Bad, No. 832, immediately south of Warmbaths.

loams. The Upper Ecca shales are in part calcareous and also contain thin beds of brown fibrous limestone. The weathering of these calcareous rocks results in the formation of dark grey or greyish black clayey soils characterised by the presence of small concretionary nodules and subsurface crusts of calcareous tufa. Soil of this nature which somewhat resembles the "Ash-turf" of the Northern and Southern Flats is in evidence to the north and north-east of Pienaars River.

The thickness of the Ecca beds ranges from a few feet to a maximum of 468 feet on the farm Spitzpunt, No. 1832, situated on the eastern margin of the Flats east of Tuinplaats. Along the western margin of the Southern Flats the thickness is also considerable. East of the railway near Pienaars River Station the beds are horizontal, but toward the north-east and north-west they assume low dips toward the north-west and north-east.

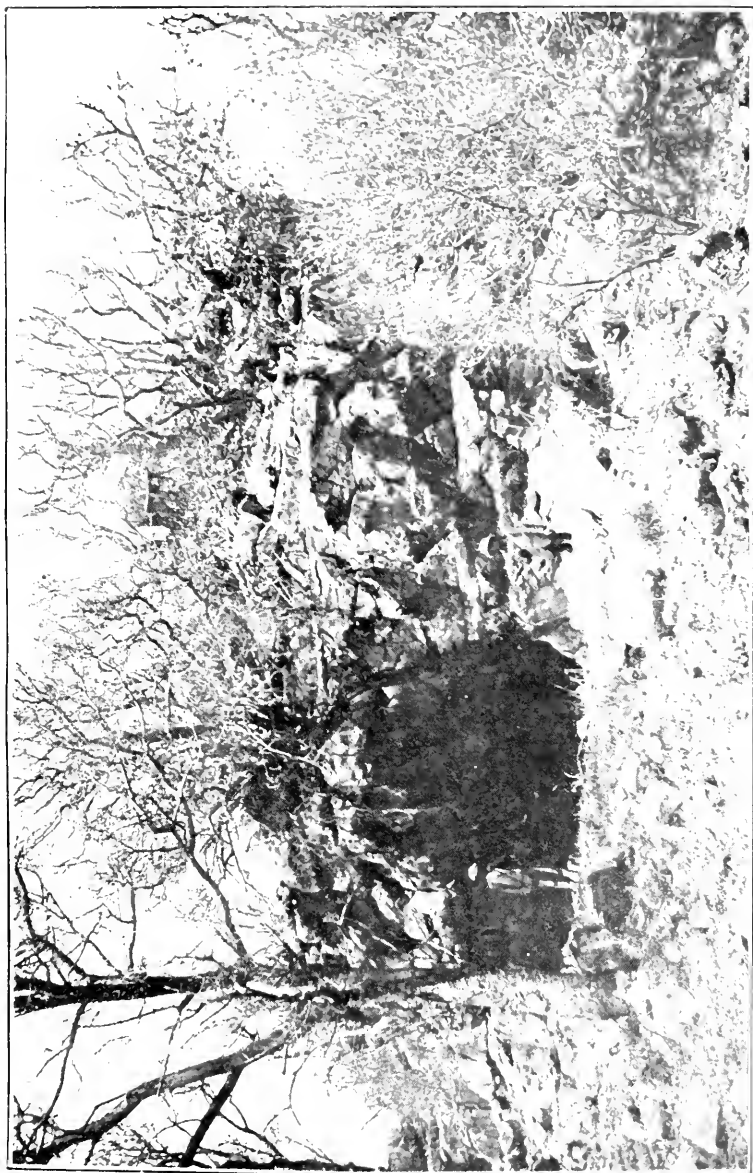
### *Stormberg or Bushveld Series.*

*The Bushveld Sandstone Series.*—This includes a Lower Division composed predominantly of massively bedded mudstones, and an Upper Division composed of massively bedded fine-grained loose-textured sandstones. The mudstones and sandstones are probably the respective equivalents of the Red Beds and Cave Sandstones of the Stormberg Series of the Cape Province and Basutoland. There is a perfectly conformable passage between the mudstones and sandstones. The former, as might have been expected, contain layers of sandstone, and beds of mudstone are in places intercalated between the sandstones.

*The Lower Division.*—This, as stated above, is made up of mudstones of red, pink, purplish-pink, and more rarely blue-grey and greenish colour, some varieties being mottled. In earlier reports these rocks are referred to as marls but as they are practically free from calcium carbonate that designation is not correct. Interbedded with the mudstones are thin layers of sandstone and sandy shale. The mudstones, like the Ecca shales, are never exposed at the surface, but have been encountered in a number of wells and boreholes. They attain their greatest development along the eastern margin of the Southern Flats. Thus a borehole on the farm Goedvoer, No. 294, passed through nearly 300 feet of these rocks, and one on the adjoining farm Middelboom, No. 1906, through 250 feet.

They give rise to flat tracts of tree-steppe covered with brownish sandy loam. Typical stretches of such country are to be seen on the farms named above and in the area to the east of them. It somewhat resembles parts of the Flats proper. The main difference lies in the nature of the arboreal vegetation. The *Keirie Klapper* and other species of Combretaceæ predominate and are accompanied by *Acacia robusta*, *Rooibosch*, Sweet Thorn and rather emaciated examples of *Acacia giraffæ*.

*The Upper Division.*—This consists mainly of fine-grained, massively bedded, loose textured sandstones, free from pebbles and larger grains. Thin beds of mudstone are in places intercalated with the sandstones. These, as previously stated, give rise to broad swelling sandy bults, for the most part covered with trees and undergrowth, from which rise abruptly here and there steep-sided hills and ridges of fantastic outline built up of huge blocks or great castle-like masses of sandstone. These kopjes are never of great height, but owing to the level nature of the surrounding country form conspicuous landmarks for miles around. They are characteristic features of the sand belt separating the Northern and Southern Flats and of the lesser belt projecting into the former; but are also in evidence along the southern and western margins of the



Twedings Kop, on farm Gruitfontein, east of Naboomspruit, a typical example of a kopje built up of huge blocks of the Bushveld Sandstone of the Upper Division.

*Photo by Dr. P. A. Wagner*





Southern Flats. Buiskop, north of Warmbaths, is the biggest of these sandstone hills. More typical examples are Tweelingskop, east of Naboomspruit, Slypsteen Kop, eighteen miles west of Warmbaths, and Molocks Kop and Middelkop, east-north-east of Pienaars River Station. In these eminences the sandstone is traversed by well marked vertical joints with prevalent east-north-eastern to west-south-western trend along which many of the great blocks and masses have been split, giving rise to clean vertical faces of the rock. The latter, however, as a rule shows no trace of bedding. Another characteristic feature of the sand belts are pans, sometimes of considerable extent, which hold water during the summer months. A fine example is the Elephant Pan near the south-eastern boundary of Roodepoort, No. 1974. Pans, it should be noted, are not met with on the Flats proper.

The sandstones range in colour from deep brick-red through red, pink, yellow and grey to white and cream. They frequently show a peculiar mottling. This is in different colours. Thus there were noted red, white-mottled, pink, greenish-mottled, and pink, grey-mottled varieties. The sandstones, as we have remarked, are ordinarily soft and loose textured. Locally, however, they are found to be hard or to contain hard patches, such hard patches being irregularly scattered through the normal soft rock. They are also frequently seen to have suffered surface silicification, as a consequence of which exposed surfaces of the sandstone are covered with a hard quartzitic crust. In many instances this silicification has proceeded from joints and irregular cracks, the sandstone remote from these being soft and unaltered. Where this is the case the sandstone on weathering develops a curiously pitted or honeycombed surface, the most bizarre patterns being sometimes developed. Fine examples of such honeycomb weathering are to be seen on the eastern slopes of Tweelingskop.

The sandstones for the most part lie horizontally or dip at low angles, the dip rarely exceeding  $10^{\circ}$ . The predominant directions of dip are indicated on the accompanying map. Locally much higher dips are, however, observed. These are due in some instances to the sub-surface weathering of the mudstone interbedded with or underlying the sandstone. In other instances the cause of the disturbed dip is not clear.

The Series appears to attain its greatest thickness beneath the central part of the Southern Flats. Thus the deep borehole on Diepsloot, No. 1738, to the north of Tuinplaats, passed through approximately 645 feet of sandstone, and the borehole on Ludlow situated some distance to the south-west through 600 feet of the rock. Along the northern margin of the Southern Flats and on the Northern Flats the thickness nowhere exceeds 250 feet.

The sandstone is seen under the microscope to be composed mainly of subangular and rounded grains of quartz averaging about 0.15 millimetres in diameter. The quartz grains are accompanied by occasional particles of felspar—chiefly microcline-zircon and other minerals. The sandstones are, as previously remarked, generally devoid of bedding planes, though diagonal bedding is to be seen in places. These features point to the rock being of æolian or wind-borne origin. Only in the basal portion of the Series is the sandstone ever distinctly stratified and here it is also sometimes interbedded with layers of grit and conglomerate. It is probable from this that the basal portion of the Series was laid down under water, while the rest of it, as we have seen, is in all likelihood mainly an æolian or wind-borne deposit formed under desert or semi-desert conditions.

The sandstones give rise on weathering to thick sheets of fine sand of pale-yellow colour covering the broad bults previously referred to. These carry a characteristic growth of *Seringa*, *Morula* and Camel-thorn trees.

The sand belts are continuous for miles, but here and there breaks occur in them. One such, over three miles across, was noted in the main belt bordering the Southern Flats on the east between the farms De Putten, No. 2009, and Bekend, No. 185, situated about 15 miles east-north-east of Tuinplaats Station. It is due to an abrupt local thinning of the sandstones and their replacement by mudstones.

*The Volcanic Series.*—The Volcanic Series, constituting the uppermost division of the Karroo System is made up as in other parts of South Africa of great flows of basaltic lava with which lenses and beds of tuff and sandstone are intercalated. The lavas and associated pyroclastic rocks are products of long-continued volcanic action during late Triassic times, when they were emitted by volcanoes and great fissures in the earth's crust. The position of the vents or fissures from which the lavas of the area under review issued has not as yet been located. The volcanic activity clearly began before the close of the period represented by the Bushveld Sandstone as sheets of basalt are sometimes found intercalated with sandstones, as for instance on Voordeel, No. 1796. On the other hand, beds and lenses of sandstone are, as previously indicated, found interstratified with the lavas near the base of the volcanic rocks. The isolated patches of sandstone completely surrounded by basalt shown on the accompanying map are of this nature.

The ancient lavas and the rocks associated with them underlie the whole of the Northern and Southern Flats and are responsible for the peculiar physical and botanical features of these remarkable areas. They are, however, rarely seen to outcrop except in the highest portions of the great undulations that vary the surface of the Flats. Thus on the farm Vlaklaagte, No. 2000, on the Northern Flats and on Klippan, No. 1995, on the Southern

The basalts are commonly referred to as the Bushveld Amygdaloid, but while much of the rock is amygdaloidal, compact non-vesicular basalt also occurs. In some areas the amygdaloidal lava forms irregular patches and areas in non- or minutely vesicular. Petrologically the basalts are very similar to those capping the Drakensbergen in Natal and Basutoland. They are fine-grained greenish-black or dark-grey rocks generally crowded with amygdales, which on weathering assume a purplish-grey or purplish-pink colour. The decomposed upper portions of the rock frequently exhibit a peculiar platy structure which becomes accentuated when, as frequently happens, calcareous tufa is deposited in the joints and cracks.

Microscopic sections show a ground mass composed of irregular grains of light coloured augite, laths of plagioclase feldspar, crystals of magnetite and ilmenite and irregular prisms of apatite, with usually some dark-coloured opaque interstitial glass. Through this are scattered isolated pseudomorphs after crystals of olivine and occasional larger plagioclase crystals or aggregates of such crystals. The steam cavities or vesicles are occupied by banded agate, opal, chalcedony or, as is more commonly the case, by radial or fan-shaped aggregates of white prisms of scolecite and other zeolites surrounded by a thin outer zone of dull green chlorite. The zeolites are sometimes accompanied or replaced by calcite. These infilled vesicles or amygdales are for the most part of irregularly ovoid form and range in diameter from a small fraction of an inch to 6 inches. On the farms Mooipan, No. 1916, and De Kuil, No. 1973, situated respectively on the Northern and Southern Flats, there were noted interesting branching "pipe" amygdales. At the former locality these consist of scolecite and at the latter of opal.

Little is known of the thickness of the Volcanic Series in different parts of the area. The greatest thickness so far recorded is on the Southern Flats

where the deep borehole on Ludlow, situated 14 miles east-south-east of Warmbaths, passed through 996 feet of these rocks before entering the underlying sandstone. In the borehole on Diepsloot, No. 1738, 588 feet of basalt were passed through. Judging by the development of the volcanic series in other parts of South Africa even the thickness recorded on Ludlow is far below the original maximum thickness.

Sheets of Karroo dolerite intrusive in the Ecca Series are exposed in the neighbourhood of Pienaars River and also along the eastern margin of the Northern Flats.

*Soils of the Flats.*—The decomposition of the amygdaloidal and compact basalts gives rise to the fertile black, red and chocolate coloured soils that have made the Flats famous. The black or "black turf" soil takes pride of place in this respect. It is a heavy clay soil of greyish black or bluish-black colour rich in colloids, which swells very considerably when wetted and on drying develops gaping shrinkage cracks that divide it into polygonal columns. It frequently contains small nodular concretions of calcium carbonate and agates derived from the weathering of the amygdaloidal basalt. Marchand has shown that contrary to popular belief the "black turf" is not very rich in humus, and that its remarkable fertility is due mainly to the high ratio of "available" to "total" phosphorus revealed by numerous analyses. Marchand also finds that "total" phosphorus is on the whole fairly high. The black turf forms a layer from 1 foot to 7 feet in thickness generally underlain by nodular surface limestone which may be up to 30 feet in thickness. In places, however, it passes directly into the underlying weathered basalt.

The chocolate and red soils are also very fertile, but require manuring after a few seasons, whereas the "black turf" appears to be almost inexhaustible. The distribution of these several types of soil is puzzling, and in travelling across the flats they appear to alternate in a bewildering manner. Speaking generally, the "black turf" appears, however, to develop where soil drainage conditions are poor or entirely lacking, while the chocolate and red soils form on ground with an appreciable slope where better drainage conditions exist. This, however, is a subject on which much detailed investigation remains to be carried out. In addition to the types of soil named what is known as "Ash turf" is in places developed. The name is differently used by different farmers. The only example that the writer saw is of blackish grey colour and appears to owe its colour to the presence of finely divided calcium carbonate.

Marginal to the Flats proper, *i.e.* along the borders of the sand bults are developed red and brownish-red sandy loams formed by the intermingling of the products of decay of the sandstones and basalts. These soils are also very fertile. Fine examples of the Huilboom (*Peltophorum africanum*) and *Acacia robusta* appear to be specially characteristic of the areas occupied by these mixed soils.

The following are typical analyses of Springbok Flats soils. Those given in Columns IV and IX were kindly made at the writer's request by Dr. B. de C. Marchand. The other analyses were also all made under the supervision of Dr. Marchand. The sample from Boschplaats, No. 2110, (No. IV), was taken near the eastern edge of the Southern Flats, about 400 yards from the contact of the basalts with the underlying Bushveld Sandstone. This accounts for the fact that it is much richer in "sand" and "fine sand" than the "black turf" normally is, and at the same time poorer in lime.

TABLE OF SOIL ANALYSES.

Nature of Soil .. .. .	iv Black Turf.	vii Heavy choco- late coloured soil.	ix Red Sandy Loam.
Farm .. .. .	Boschplaats No. 2110.	Deeside No. 2335.	Byzonder No. 1792.
Situation .. .. .	Southern Flats.	Southern Flats.	Southern Flats.
District .. .. .	Waterberg.	Waterberg.	Waterberg.
Moisture .. .. .	7·21	5·10	0·96
Loss on Ignition .. .. .	7·13	7·31	2·38
Stones (over 3 mm) .. .. .	Nil.	Nil.	Nil.
Fine gravel (1·3 mm) .. .. .	0·10	0·60	0·30
Sand (0·2-1 mm) .. .. .	15·50	10·65	44·00
Fine Sand (·04-·2 mm) .. .. .	20·20	23·56	35·20
Silt (·01-·04 mm) .. .. .	..	5·55	1·50
Fine Silt (·004-·01 mm) .. .. .	..	3·47	1·20
Very fine Silt (·002-·004 mm) .. .. .	..	2·13	1·10
Clay (·002 mm) .. .. .	..	41·48	11·90
Insoluble Matter .. .. .	71·81	66·14	90·28
Alumina .. .. .	7·25	} 19·95	3·76
Ferrie Oxide .. .. .	4·24		2·32
Lime .. .. .	0·67	0·14	0·09
Magnesia .. .. .	1·35	0·05	0·19
Potash .. .. .	0·62	0·19	0·13
Phosphoric Oxide .. .. .	0·03	0·05	0·02
Nitrogen .. .. .	..	0·1155	..
" Available " potash .. .. .	..	..	..
" Available " phosphoric oxide .. .. .	..	..	..

## 4. SUPERFICIAL DEPOSITS.

The superficial deposits which over wide areas conceal the underlying rocks comprise sands, the several types of soil already referred to, "oukclip" or lateritic surface ironstone, and calcareous tufa occurring as nodular concretions and hard compact sheets. The sands are confined to the outcrops of the Bushveld sandstone and of the Coal Measure sandstones and grits. The "oukclip" and surface limestone, on the other hand, are not characteristic of any particular formation, occurring on almost every kind of rock found in the area. Thus the former forms continuous sheets overlying Bushveld amygdaloid on the Naboomspruit townlands, but is also seen on Weltevreden, No. 380, and other localities to overlie Bushveld Sandstone, and in the southern part of the area it is found resting on felsite and red granite. Massive beds of "oukclip" may be seen in process of active erosion in some of the water courses of the area. The main accumulations of sand and calcareous tufa probably date from a period when desert or semi-desert conditions prevailed over this part of the Transvaal, there being clear evidence of a marked increase in the rainfall within comparatively recent times. The latter, it should be stated, is most abundant on the volcanic rocks and on the Upper Ecca beds.

*Stone Implements.*—No account of the geology of the Springbok Flats would be complete without some reference to the crude palaeolithic stone implements including bouchers, points, scrapers and arrowheads which are of widespread occurrence in the superficial deposits of the area. On the Flats proper, where they are found lying on the surface, it is impossible to go many yards in any direction without coming across them; the ubiquity of such palaeoliths being not the least remarkable feature of these very interesting tracts of country.

The implements are clearly the hunting equipment of Bushmen and other primitive peoples who roamed the Flats at a time when these teemed with game of every description. They are mainly of felsite and quartzite, but more delicately fashioned implements of chalcedony and opal are also sometimes found. Felsite implement "factory sites" were located on the farms Fraseate, No. 1850, and Klavervallei, No. 1885, on the south-eastern margin of the Northern Flats, and very extensive "workshops" for quartzite implements existed on the west side of Makeeps Vlei. The implements were probably fashioned at many other localities.\* The weathered condition of many of the implements proves that they are of considerable antiquity. This is also proved by the conditions in which they are occasionally found. Thus on the farm Bultfontein, No. 1904, small bouchers and scrapers were found resting on Ecca Shale beneath a layer of calcareous tufa, 2 feet thick, overlain by 3 feet of sandy loam.

### 5. WATER SUPPLY OF THE AREA.

While the Springbok Flats are on the whole very poorly off as regards surface water, there appears to be no difficulty in tapping moderate supplies by means of wells and boreholes either in the sandstones or the basalts. The basalts in particular rarely fail to yield water at the bottom of the zone of weathering, which lies at anything from 20 to 80 feet below the surface. The underground water over considerable areas of the Flats appears to be stagnant, owing no doubt to the absence of surface relief. It is in consequence heavily charged with calcium carbonate and other salts. In some instances the latter are so abundant as to render the water unfit for consumption. In the sandstones the underground water table also stands from 15 to 80 feet below the surface. Exceptionally, however, it is much lower.

The most unsatisfactory rocks so far as underground water supplies are concerned are the mudstones underlying the Bushveld Sandstone. Along the eastern border of the Southern Flats where these rocks, as previously stated, attain a considerable thickness, a number of boreholes have been put down to depths of 200 and even 300 feet, either without yielding any water at all or only quite unimportant quantities. This is doubtless a consequence of the impermeable nature of the mudstones and the absence of joints in them.

Hopes were at one time freely entertained of striking artesian water beneath the Flats. All that can be said on the question is that the structural conditions are favourable to the occurrence of artesian supplies. This, however, is only one of the requisite conditions and, judging by the results so far obtained in the deep boreholes already referred to, some of the other conditions are not present.

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\*There is said to be a very important "factory site" on the farm Wellington, No. 2010, situated four miles west-north-west of Settlers.

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## SOILS.

(Refer also to the chapter on the Geology of the Flats contributed by Dr. P. A. Wagner in which he includes a detailed account of its soils.)

The following report on the soils of the Springbok Flats has been kindly supplied by Dr. B. de C. Marchand, Senior Chemist, Department of Agriculture, Capetown :—

The soils occurring in this area may be divided into four main types, two of which are undoubtedly derived from the basalt chiefly, one undoubtedly from the sandstones and one which is certainly derived largely from the sandstones, but in the formation of which it is possible that the basalt has played a part. Several other varieties of soil occur, but all of these may be regarded as variants of the four main types.

Soils exactly similar have not been noted from other parts of the Transvaal and it is unlikely that they are to be found in any other part of the Province except on the border between the Union and Portuguese East Africa where rocks belonging to the same geological horizons as those occurring on the Flats are met with. No soil samples from this portion of the Transvaal have so far been received.

The four soil types referred to are :—

- I. The Black Turf.
- II. The Red Heavy Loam.
- III. The Red Sandy Loam.
- IV. The Grey Sandy Soil.

## I. THE BLACK TURF.

This soil is grey-black to blue-black in colour and passes through brownish-black to chocolate and red, the latter being considered separate types. It is a heavy clay, adhesive when wet and hard when dry. The soil is usually deep, well over three feet, but in many places it is underlain by a deposit of calcareous concretions. It resembles in almost every respect the norite black turf (2). In some places concretions of calcium carbonate, visible to the naked eye, may be seen in the soil. The underlying rock is mapped by the Geological Survey as amygdaloidal basalt (2), a rock which, from the chemical point of view, is very similar to the norite of the Bushveld Igneous Complex, which, under the same processes of weathering, may be expected to give rise to soil of similar character.

Maufe (4) has described a similar soil, of similar composition and origin, which occurs in Shamva, Southern Rhodesia.

*Mechanical Composition.*—The following mechanical analyses are given to illustrate the physical composition of black turf soils. The two analyses quoted from Hall (6) represent a soil cultivated for two years and one cultivated for fifteen years.

	1738. Deeside, No. 2335, Settlers.	6056. Amsterdam, No. 2043, Naboomspruit.	Hall 1. Sjamboks Kopjes, 1951, Naboomspruit.	Hall 2. Sjamboks Kopjes, 1951, Naboomspruit.
	%	%	%	%
Stones .. ..	Nil	Nil	Nil	Nil
Moisture .. ..	9.11	6.99	9.92	8.20
Loss on ignition	7.17	5.91	6.25	5.02
Fine gravel ..	2.3	1.3	..	..
Sand .. ..	8.5	12.2	12.1	12.1
Fine sand ..	18.2	16.9	15	14.7
Silt .. ..	6.7	2.8	7.1	8.6
Fine silt ..	5.4	8.7	5.8	7.4
Clay .. ..	44.4	44.7	49.1	48.2

These figures show the soil to be a heavy clay. The presence of calcium carbonate, however, apparently ameliorates the texture very considerably. At any rate, these soils are much more easy to work than one would expect of soils of such high clay content. In some parts the soil cracks badly on drying out, while in others the cracking is not apparent.

The sub-soil is practically identical with that at the surface in mechanical composition, and the uniformity continues until the underlying calcareous nodules, which in turn rest upon hard limestone overlying the basalt, or until the decomposing basalt is reached.

The soils are adhesive when wet and if worked in this state dry out rather hard, forming clods which do not break up readily. When very wet they are almost impassable to transport.

*Chemical Composition.*—The following analyses may be considered typical of the Springbok Flats black turf. The first three samples are from the "Settlers" area in the south and the remainder from the central or Naboomspruit area.

Sample No. ..	2730	723	1738	Hall 1.	Hall 2.	6056
Locality .. ..	Worthington, No. 2351.	Ludlow, No. 2355.	Deeside, 2335.	Sjamboks Kopjes, 1951.	Sjamboks Kopjes, 1951.	Amsterdam, 2043.
	%	%	%	%	%	%
Moisture ..	6.52	8.85	9.11	9.92	8.20	6.99
Loss on ignition	10.18	10.88	7.17	5.25	5.02	5.91
Insoluble matter	65.76	60.20	63.02	66.89	67.48	70.21
Iron oxide and alumina ..	14.56	14.19	19.25	15.82	14.84	13.59
Lime .. ..	2.17	4.43	1.02	1.80	1.80	1.30
Magnesia ..	0.03	1.03	0.10	0.26	0.21	1.61
Potash .. ..	0.04	0.57	0.45	0.28	0.27	0.29
Phosphoric oxide	0.03	0.06	0.07	0.07	0.08	0.03
Total .. ..	99.29	100.21	100.19	100.29	97.90	99.93
Nitrogen ..	0.091	0.127	0.133	0.102	0.10	0.088
Available potash	0.0076	0.0081	0.0140	0.016	0.021	0.0131
Available Phosphoric oxide	0.0104	0.0095	0.005	0.0069	0.0087	0.0020



Chemically these soils are characterized by a high percentage of lime, of which a moderate proportion is present as calcium carbonate. They invariably have an alkaline reaction. As a rule the amounts of potash they contain are reasonably high, though not abnormally so for the Transvaal. The amounts of nitrogen and organic matter are not high, and the soils are not, as is commonly supposed, rich in humus. The appellation "turf" is a misnomer, due most likely to error of observation on the part of the pioneers of farming on this class of soil. The High Dutch word "turf" is, of course, the equivalent of the English "peat," the German "torf" being a cognate bearing the same meaning. In the Union the word turf was apparently applied to black soils, owing no doubt to the superficial resemblance to peat. Subsequently the word has acquired a derived meaning on the recognition of the non-peaty nature of the so-called turf soils, and is most frequently used to denote a heavy clayey soil such as the majority of the black soils found in the country undoubtedly are. With this new significance the word has been applied to soils of a clayey texture which do not bear the slightest resemblance to peat, and we hear of "rooi-turf" and "vaal-turf" as well as "swart-turf." Unfortunately, the name "turf" is still attached to soils of an undoubted peaty nature such as those described by Hall in the *June*, 1923, number of the "Agricultural Journal." We thus have, in Afrikaans, the same name applied to two entirely different kinds of soil, one sedimentary and covering large stretches of country as a rule, and the other purely of local occurrence. This use of the word turf should be borne in mind, as remarks made on the one kind do not necessarily apply to the other.

To return to the organic matter in the Springbok Flats black turf, we find that the loss on ignition, which is a rough measure of the organic matter present in the soil, is by no means high, the average for the samples analysed being just over 8 per cent. Now, in heavy clay soils of this nature a considerable portion of the loss on ignition represents water chemically combined with the clay, so that in forming an estimate of the organic matter in the soil the figure for loss on ignition must be considerably discounted. The average loss on ignition for the six samples of Koedoespoort red loam, the analyses of which were published in the *November*, 1920, issue of the "Agricultural Journal," is a little over 9 per cent. Now, even if we decrease this figure on account of combined water to the same extent as that for Springbok Flats black turf containing on an average a higher percentage of clay, we must come to the conclusion that the latter soil is poorer in organic matter than the former and consequently that the term peat cannot by any stretch of imagination be connected with the black turf. The average percentage of nitrogen is just above 0.1, an amount which would scarcely be considered satisfactory under European conditions, but which experience has shown to be satisfactory in the Transvaal as indicating that the soil will in all probability not benefit by the application of the nitrogenous manures for many years.

The average percentage of phosphoric oxide is relatively high, but some of the samples analysed are but poorly supplied in this respect, *e.g.* Nos. 2730 and 6056 in the above table. Vipond (6) drew attention to the importance of a high lime-content as affecting the proportion of the phosphoric oxide in the soil regarded as available. Now, these soils contain comparatively high percentages of lime, and show what for the Transvaal are very satisfactory percentages of "available" phosphoric oxide.

It has recently been shown that the ratio of "available" to "total" phosphoric oxide is of far greater importance than the absolute quantities in determining the capacity of the soil to supply the plant with phosphoric oxide. It is just in this respect that the Springbok Flats black turf shows

up so strongly in comparison with other Transvaal soils. We may compare this soil with the Koedoespoort red loam, which contains on an average an equal percentage of total phosphoric oxide.

	Total Phosphoric Oxide.	Available Phosphoric Oxide.	Percentage of Total which is available.
Koedoespoort red loam ..	0.07	0.0012	1.8
Springbok Flats black turf ..	0.06	0.0076	16.7

The phosphoric oxide content of this soil type, though it compares favourably with most of the other types found in the Transvaal, is, as usual, its weakest point.

As far as we are aware no manurial experiments have been carried out on the Springbok Flats black turf. Maize is the principal crop grown and is apparently never manured. Though yields may be poor for the first year or two, they rise up to fifteen bags or more per acre subsequently, and the soil is said to stand continuous cropping for twenty or thirty years without manuring and without any decrease in yield. This, notwithstanding, we are of opinion that light dressings of superphosphate will amply pay for the trouble and expense of application and that the incorporation of organic manure will materially assist in ameliorating the somewhat unkindly nature of the soil. The treatment advised is, in fact, exactly the same as that recommended for the norite black turf, as these two soil-types are scarcely distinguishable from one another in the field, while in general chemical and physical make-up they are very similar.

#### *Asgrond or Ash Soils.*

These may be regarded as a variety of the black turf type. The term "Asgrond" is applied to soils which, whilst in many respects resembling the black turf, are rather more grey than black in colour and as a rule have a higher content of calcium carbonate. It is doubtful whether these ash soils exhibit field characteristics differing from those of the black turf to any extent, except that they have a somewhat better texture, owing no doubt to the extra calcium carbonate present, as clods found in working disintegrate readily to a granular condition.

*Chemical Analysis.*—The following table gives the analyses of two samples known as "Asgrond" and two termed dark grey heavy loam from Deeside, No. 2335, Settlers.

Number of Sample	1734	1735	1736	6980
Locality	Deeside Settlers.	Deeside Settlers.	Deeside Settlers.	Welbekend, No. 2088, Naboom- spruit. Asgrond.
Description	Asgrond.	Grey heavy loam.	Grey heavy loam.	
Moisture .. ..	5.00	4.73	4.82	7.49
Loss on ignition .. ..	7.49	5.92	6.86	6.81
Insoluble matter .. ..	67.69	69.50	69.38	66.91
Ferric oxide and alumina ..	13.27	16.90	15.40	13.84
Lime .. ..	5.60	1.48	3.97	1.20
Magnesia .. ..	0.14	0.18	0.10	1.92
Potash .. ..	0.10	0.14	0.26	0.93
Phosphoric oxide .. ..	0.08	0.08	0.08	0.04
Nitrogen .. ..	0.095	0.112	0.108	0.129
Available potash .. ..	0.0053	0.0080	0.0036	0.387
Available phosphoric oxide	0.0002	0.0105	0.0052	0.0029

Sample No. 6080 from Welbekend submitted as "Asgrond" in the absence of any data regarding field differences, we should be inclined to class as a black turf since the usual characteristic feature of "Asgrond," namely a high calcium carbonate content, is absent.

(NOTE.—Notwithstanding the lower lime content, this sample has the characteristic grey colour and loose, open character of asgrond, is much less boggy in wet weather than black turf and in its easy working and the greater prevalence of rooibloem (*Striga lutea*) is typical of the former. In searching for a representative sample of asgrond for analysis this soil was recommended to me as being typical by some of the leading farmers in the neighbourhood. It may be that the lower lime content of the first foot of soil from which the sample was taken in the usual manner is made up for by the fact of the subsoil being particularly rich in lime and gradually merging into a deposit of secondary lime at a depth of three or four feet.—E.E.G.)

## II. THE RED HEAVY LOAM.

This type of soil has also apparently been derived *in situ* from the amygdaloidal basalt, either by a different process of weathering, or from a phase of the rock differing in composition from that which gives rise to the black turf.

The chocolate soils are generally supposed to be intermediate both in situation and character between the true red and the black. They are, however, except in colour, almost identical with the red soils and very different from the black in many respects. Apart from colour, the fundamental points on which the red and chocolate soils differ from the black turf are :—

- (1) A lower percentage of lime.
- (2) A higher percentage of oxide of iron and of alumina taken together.
- (3) A lower percentage of available phosphoric oxide.
- (4) The black turf has invariably an alkaline reaction to litmus while some samples of the heavy red loam are acid, others alkaline.

Mechanical analyses show practically identical figures for the two types. Their physical properties are however by no means identical.

The red and chocolate soils, like the black turf, are usually well supplied with potash and fairly well supplied with nitrogen. The phosphoric oxide content is on the low side and the percentage of this which is soluble in citric acid (available) is extremely low. The following table compares the total and the available phosphoric oxide in the red loam and the black turf :—

Type.	No. of Samples.	Total Phosphoric Oxide.	Available Phosphoric Oxide.	Percentage of total which is available.
Red Loam ..	11	0.06	0.0024	4
Black Turf ..	8	0.05	0.0077	15.4

The statement has been made that this type of soil does not respond to superphosphate. We have soils somewhat similar to these Springbok Flats red loams all over the Transvaal and it has been repeatedly demonstrated that the application of phosphatic manures gives greatly enhanced yields.

We have had no properly conducted manurial trials on this soil type, but in 1910-11 a small co-operative experiment was carried out on the farm Deeside, No. 2335, Settlers. This experiment was unfortunately partially spoiled by a heavy wind which arose after the fertiliser on plots 1, 2 and 3 had been distributed and which took away a good deal of the fertiliser. The results show, however, that applications of phosphates are beneficial on this type of soil. It would seem from general considerations that basic slag would be more generally useful than superphosphate.

Plot No.	Treatment	Yield of maize in lbs. per acre.					
1.	600 lbs. slaked lime	..	..	..	..	1,053	
2.	600 lbs. slaked lime	..	..	..	..	1,096	
	300 lbs. superphosphate	..	..	..	..		
3.	300 lbs. superphosphate	..	..	..	..	948	
4.	400 lbs. basic slag	..	..	..	..	1,249	
5.	None	..	..	..	..	662	

These soils contain a large amount of finely divided ferric hydroxide, and perhaps also aluminium hydroxide, which may have the effect of converting the phosphoric oxide in superphosphate into a form which is not available to plants, but that this fertiliser should have no effect seems doubtful. It may be noted also that both samples had an acid reaction to litmus, whereas several samples previously examined were found to have an alkaline reaction.

Sample No.	..	..	..	6057	6059	1740	1742
Locality	..	..	..	Turpan	Turpan,	Deeside,	Deeside,
				1933.	1933.	2335.	2335.
Description	..	..	..	Chocolate	Dark brown	Red	Red
				heavy loam.	heavy loam.	heavy loam.	heavy soil.
<i>Mechanical Analysis.</i>							
Stones	..	..	..	Nil	Nil	Nil	Nil
Fine gravel	..	..	..	0.1	0.1	2.9	0.9
Sand	..	..	..	14.8	14.6	10.6	9.5
Fine sand	..	..	..	16.2	20.4	20.2	18.4
Silt	..	..	..	2.6	1.6	4.9	5.1
Fine silt	..	..	..	2.9	3.8	4.8	5.5
Very fine silt	..	..	..	3.1	2.7	6.1	4.2
Clay	..	..	..	48.8	45.9	37.0	41.4
<i>Chemical Analysis.</i>							
Moisture	..	..	..	5.15	4.57	6.63	6.56
Loss on ignition	..	..	..	7.42	6.71	7.86	7.43
Insoluble matter	..	..	..	6.77	67.47	64.78	65.52
Ferric oxide	..	..	..	7.84	6.60	19.40	18.10
Alumina	..	..	..	12.40	12.60		
Lime	..	..	..	0.33	0.36	0.22	0.41
Magnesia	..	..	..	1.01	0.97	0.15	0.21
Potash	..	..	..	0.78	0.63	0.18	0.29
Phosphoric oxide	..	..	..	0.04	0.04	0.09	0.06
Nitrogen	..	..	..	0.109	0.150	0.118	0.125
Available potash	..	..	..	0.0289	0.0262	0.0163	0.0206
Available phosphoric oxide	..	..	..	00.0009	0.0011	0.0012	0.0011

It will be noticed that these red loams contain over 40 per cent. of clay and should on the basis of mechanical composition be classed as clay soils. We prefer to term them heavy loams owing to their behaviour in the field.

It is noteworthy that samples Nos. 6,059 and 6,060 (see analysis of latter under III. The Red Sandy Loam) have both been described as "red loam" yet physically these soils are totally different, the former containing over 45 per cent. of clay while the latter is estimated to contain not more than 15 per cent.

The greater prevalence of "witch weed," or "rooibloem," as it is called locally (*Striga lutea*) on the red soils, as compared with the black turf, has been noted by Pearson (5), but no satisfactory explanation of this difference has been forthcoming.

(NOTE.—Owing to the physical nature of the black turf, the germination of all seeds is more difficult on it than on other soils, and this is probably the reason of its comparative immunity from infestation by *Striga lutea*. This view is supported by the fact that when the somewhat refractory nature of the black turf is ameliorated by the addition of lime, as occurs in what is known as "asgrond," this pest is liable to become just as troublesome as on the red soils. The seeds of *Striga lutea* are minute and require good conditions to enable the resulting seedling of this root parasite to exist until it can attach itself to the root of a mealie plant, or other grass host, upon which it depends for sustenance. Even with large seeds containing such an ample reserve of plant food as the mealie, farmers have to contend against considerably greater difficulties of germination in the black turf than in any other of the local soils unless the moisture conditions are favourable, and it not infrequently happens that, owing to poor germination, the black turf lands have to be planted a second time, when on the adjoining red lands this has not been found necessary.—E.E.G.)

### III. THE RED SANDY LOAM.

These soils, while somewhat similar in superficial appearance to the previous type, differ very considerably in mechanical and chemical composition from that type. They are much lighter in texture, consisting for the most part of sand of even grain. They appear to contain from 10 to 17 per cent. of clay with very little silt and may be classed as sandy loams. The sand consists chiefly of clear quartz which is extraordinarily well rounded, many grains being practically perfect spheres. It would seem that these soils are derived from the Bushveld Sandstones (the Cave Sandstones of the Cape Province and the Forest Sandstone of Rhodesia). The well rounded grains are in keeping with an aeolian origin of the parent rock.

The following analyses are of representative samples :—

Sample No. . . . .	6060	6061	2060
Locality . . . . .	Roodepoort, No. 1974, Naboomspruit.	Mooihoekspoort No. 1978, Naboomspruit.	Middelkopje, No. 5, Northern boundary Pre- toria District. Red sandy loam.
Description . . . . .	Red sandy loam, Acacia veld.	Red sandy loam, Rooibos veld.	
<i>Mechanical Analysis.</i>			
Stones . . . . .	Nil	Nil	Nil
Fine gravel . . . . .	0.7	0.1	0.9
Sand . . . . .	49.0	43.1	41.3
Fine sand . . . . .	27.2	38	30.6
Silt . . . . .		1.6	2.3
Fine Silt . . . . .	(By difference)	1.4	0.9
Very fine silt . . . . .	23.1	1.4	1.4
Clay . . . . .		10.1	17.2
<i>Chemical Analysis.</i>			
Moisture . . . . .	1.21	0.62	2.14
Loss on ignition . . . . .	3.00	2.76	3.71
Insoluble matter . . . . .	88.35	89.69	84.53
Ferric oxide . . . . .	2.76	2.52	3.38
Alumina . . . . .	4.51	4.15	5.84
Lime . . . . .	0.25	0.05	0.08
Magnesia . . . . .	0.23	0.19	0.09
Potash . . . . .	0.12	0.08	0.16
Phosphoric oxide . . . . .	0.03	0.03	0.03
Nitrogen . . . . .	0.070	0.059	0.066
Available potash . . . . .	0.0133	0.0242	0.0118
Available phosphoric oxide . . . . .	0.0009	0.0007	0.0005

Chemically these soils are but poorly supplied with plant food. Sample No. 6060 seems to be rich for this class of soil but in the absence of additional data it is impossible to decide whether it is exceptional or not. This sample is stated to occur overlying lime conglomerate and this may account for the comparatively high lime and magnesia content. Apart from this, the sample cannot be distinguished from No. 6,061 or No. 2,060, the latter a sample from Middelkopje 365 on the northern boundary of the Pretoria District. Of these three samples No. 2,060 is the heaviest and 6,061 the lightest, but there is no great difference in texture and physical properties.

We have unfortunately no information on the productive capacity of this soil type. From general considerations one would expect a good response to both artificial and kraal or stable manures excepting those containing potash. The application of phosphates would appear to be essential for the production of good crops.

It is stated that on these soils also the failure to respond to the application of artificial fertilisers has been noted. This is difficult to understand as there is certainly nothing in the chemical analysis to indicate why this should be. Samples Nos. 6,061 and 2,060 have an acid reaction to litmus, while No. 6,060 is about neutral, if anything slightly alkaline: reaction would not account for the failure to respond to phosphatic manures. The

samples have not been examined for the presence of brak salts, which might be a limiting factor, as the occurrence of brak in soils of this class in the Transvaal is extremely unlikely and in the absence of positive field evidence thereof this adverse factor may be ruled out. It may be possible that adverse moisture conditions form the limiting factor in the case of sample No. 6,061 as this light open soil overlying a porous sandstone must drain rapidly and possibly may cause droughty conditions. On the other hand, it is said that the soil represented by No. 6,059 does not respond to manuring while that represented by No. 6,062 does (see analyses of grey sandy soils). Now, the former sample is a heavy soil which retains water well, while the texture of the latter is even lighter than that of No. 6,061. It would seem therefore that water conditions cannot be the sole cause of the failure to respond to manuring.

The total percentage of ferric oxide on these soils is not high, in fact it is less than 50 per cent. of that contained in the soils of the red heavy loam group and much less than that contained in certain other Transvaal soils which respond well to manuring. The whole matter is quite inexplicable in the light of our present knowledge and no good purpose can be served by attempts at explanations in the absence of positive evidence.

While these red sandy loams undoubtedly owe their origin for the greater part to the fine-grained massive Bushveld Sandstones, it is possible that some of the fine material at least may be derived from adjacent amygdaloidal basalt or may be the remains of a former overlying layer of the basalt. The occurrence of the grey fine-grained sandy soils, also undoubtedly derived from the Bushveld Sandstone, lends some support to this view. On the other hand, the red sandy loam may be derived from a variety of the sandstone richer in iron and aluminium compounds than that from which the grey sandy soils are derived.

(NOTE.—Although, as pointed out by Dr. Marehand, the analyses, both mechanical and chemical, show samples 6,060 and 6,061 to be of the same type and to have little to distinguish them beyond the somewhat greater richness of 6,060 and its much higher lime content, they carry two distinct plant associations, the vegetation on soils represented by 6,060 being that of a typical *Acacia* veld, such as is associated with the basaltic loams, whilst the soils represented by 6,061 carry *Rooibos* veld, characterised by the prevalence of *Combretum apiculatum* (*Rooibos*) which is only found growing in *Zuurveld*. There is an equally marked difference in the productive capacity of the two soils. The land from which 6,060 was taken yielded the previous season 18½ bags of shelled mealies to the acre without having ever been manured or fertilised in any way and always produces good crops, whilst those adjacent to 6,061 and composed of the same soil as the latter scarcely pay for cultivation and at best yield only three or four bags per acre.

Whilst there seems little doubt that 6,061 owes its origin to the Bushveld sandstone which underlies it and forms the surrounding ridges, the field indications are that 6,060 is derived in part from the basalt. The portion of the land from which it was taken is underlain by secondary limestone of unusual thickness—about 40 feet in a neighbouring borehole—but, further along, about a couple of hundred yards to the east, the soil is underlain by decomposed basalt and, with the exception of a small patch of black turf, continues to be somewhat light in character.

The few attempts hitherto made to obtain larger crops from this soil by the application of fertilisers have given very disappointing results. This

is certainly not due to brak salts, the presence of which can always be noted by the nature of the vegetation, which does not show the slightest trace of brak.

The following are the particulars of the fertiliser experiments at Roodepoort on the soil represented by sample No. 6060, which is from six to ten feet deep and very uniform, there being no noticeable difference between the bottom layers and the surface soil. Although, as shown in the table given further on, under "physical properties," its water capacity is small, the crops grown on it stand up against drought remarkably well, certainly fully as well, if not better, than those on the black turf and heavy loams in the neighbourhood having a much greater water capacity.

Mr. T. D. Hall, Research Chemist, School of Agriculture, Potchefstroom, having occasion to visit the neighbourhood in 1923, I pointed out to him that my son and I had tried various fertilisers at Roodepoort without any very satisfactory results and showed him some plots treated, respectively, with lime and basic slag, which were most disappointing. He said that the soil certainly ought to give beneficial results from the application of suitable fertilisers and that with our co-operation he would like to carry out a series of experiments to find out just what this class of soil, *i.e.*, that represented by Analysis No. 6,060 required.

Accordingly, 84 plots of one-fortieth acre each were marked out in October, 1924, and arrangements made to carry on the experiments for four years, dividing the whole into four groups of 21 plots each, planted, respectively, with mung beans, maize, peanuts and cotton, each crop to be annually shifted to the next group of plots, so as to form a rotation; the various fertilisers experimented with to be applied to the maize and cotton crops only, the mung beans and peanuts benefiting by the residues when brought by rotation on to the plots occupied the previous year by the maize and cotton crops.

A full report of the first year's results is published in the *Agricultural Journal* for March, 1926.

These results, briefly stated, show :—

- (1) That on cotton lime had the same depressing effect as noted with maize the previous season.
- (2) Superphosphate was decidedly beneficial for improving the quality as well as increasing the quantity.
- (3) Nitrogen combined with superphosphate was profitable and gave increased yields. That there is a clear indication of a shortage of nitrogen on this soil.
- (4) Potash has not shown up or been profitable in any combination.

From the results thus far obtained, Mr. Hall's recommendations for this soil are that *for* cotton farmers are advised to try 150 lb. of superphosphate and 50 lb. of ammonium sulphate per acre. If desired 66 lb. nitrate of soda can be used in place of 50 lb. ammonium sulphate.

*Season 1925-26.*—No official report has yet been published. In spite of the unfavourable season the fertilisers as a whole showed up very well.

*Maize.*—Although only having 8.57 inches of rain during the growing period, satisfactory gains were shown in almost every instance. The average of the control plots gave a yield equivalent to 1,138 lb. per acre, whilst the best of the fertilised plots, *viz.*: that receiving 300 lb. superphosphate, 100 lb. ammonium sulphate and 100 lb. chloride of potash per acre, gave



a yield equivalent to 2,540 lb. per acre ; a gain of 1,402 lb. or 123 per cent. ! As experienced before, the gains were mainly due to the superphosphate.

*Mung Beans.*—Here again the fertilised plots (fertilised the previous season only when they carried a crop of cotton) showed up well. The average yield of the control plots was at the rate of 788 lb. per acre and gains up to 287 lb. per acre, due to superphosphate, were made from the residual value of the fertiliser left over from the cotton.

*Cotton.*—Here gains of as much as 444 lb. per acre over the control plots, due to superphosphate, were shown.

The limed plots gave in most instances increased yields over those unlimed, apparently reversing the results of the previous season, though owing to faulty germination and consequently a poor stand caused by drought, it is unfair to draw conclusions from this and more trials will be necessary to establish the fact.—E.E.G.)

#### IV. THE GREY SANDY SOILS.

This type is represented by two samples, Nos. 6062 and 6063. They are grey in colour and of fine, even texture. The fine material (clay, silt, etc.,) is yellowish grey in colour and the sand is even in texture and remarkably well rounded, in fact almost exactly similar to that of the previous type.

These grey sandy soils are undoubtedly derived from the Bushveld Sandstone and their character is in keeping with that of the parent rock. Possibly the latter may be poorer in feldspars or the cementing material may consist more of silica and less of ferric oxide than that phase of the formation from which the red sandy loams are derived, or possibly the difference in the two types may be accounted for in the manner already suggested in discussing the Red Sandy Loams.

Maufe has described soils (4) occurring in Southern Rhodesia similar to these, which he considers are derived from the correlated "Forest Sandstone." They may be described as sands, the sample mechanically analysed contains but some 2 per cent. of clay, the other sample, No. 6063, being slightly more clayey but still considerably lighter than No. 6061 of the red sandy loam type.

The grey sandy soils are chemically very poor. No. 6063 contains a fair amount of potash, as does No. 1293, and its nitrogen content is satisfactory but in all other respects both samples are seriously deficient. No. 6062 is neutral and No. 6063 acid by the litmus paper test. These soils should respond well to manuring, particularly to applications of phosphates and would be improved by the incorporation of organic matter in the form of Kraal manure or green manuring. We have, however, no definite knowledge of their agricultural value. They are thin and would require a certain amount of building up in order to make them reasonably productive. Such building up by the use of artificial fertilisers and the incorporation of organic matter is a lengthy and expensive process and economically sound only when transport facilities are very favourable and lucrative crops, which also respond readily to manuring, can be cultivated.

(NOTE.—Trials on the farm "Voordeel" have shown that the richer grey sandy soils of the Sandveld Association respond very satisfactorily to the application of fertilisers and that when fertilised they yield good crops.—E.E.G.).

Sample No. . . . .	6062	6063	1293
Locality . . . . .	Mooihoekspoort, No. 1978, near Naboomspruit.	Zyferkraal, No. 1968, near Naboomspruit.	
Description . . . . .	Grey sandy loam. Typical sandveld.	Grey sandy loam. Thornboti Asso- ciation.	Grey sandy loam.
<i>Mechanical Analysis.</i>			
Stones . . . . .	Nil	Nil	Nil
Fine gravel . . . . .	Nil	0.7	..
Sand . . . . .	60.6	53.2	..
Fine sand . . . . .	33.7	30.4	..
Silt . . . . .	0.8	..	..
Fine silt . . . . .	0.7	..	..
Very fine silt . . . . .	0.6	..	..
Clay . . . . .	1.9	..	..
<i>Chemical Analysis.</i>			
Moisture . . . . .	0.16	0.39	0.28
Loss on ignition . . . . .	1.00	1.43	1.23
Insoluble matter . . . . .	97.09	93.56	96.23
Ferric oxide and alumina . . . . .	1.69	4.25	1.90
Lime . . . . .	0.08	0.07	0.05
Magnesia . . . . .	0.08	0.10	0.07
Potash . . . . .	0.04	0.13	0.12
Phosphoric oxide . . . . .	0.01	0.01	0.03
Nitrogen . . . . .	0.053	0.129	0.025
Available potash . . . . .	0.0062	0.0018	0.0040
Available phosphoric oxide . . . . .	0.0007	0.0006	0.0020

#### V. VLEI SOIL.

The sample of soil representing the alluvial deposit in the Nyl Vlei on the farm Zyferkraal No. 1968 is a dark grey fine grained clayey loam which breaks down readily to a thin mud on treatment with water, in contradistinction to the black turf which remains granular and defloculates slowly under similar treatment. The chemical analysis is given below but it was not considered worth while to subject the sample to mechanical analysis in the absence of information as to the uniformity of type over a large area. Such alluvial deposits are usually extremely variable both in chemical composition and in texture and with our present knowledge it is difficult to classify them satisfactorily.

The analysis of another sample of alluvium is included in the sub-joined table. It is similar in chemical composition as far as plant food is concerned to No. 6064 but contains much more alumina and ferric oxide and is lighter in texture. This sample No. 1924, came from the farm De Brak No. 691, which is not very far from Zyferkraal.

The analysis of such a sample must be regarded as indicating the composition of the soil in a particular spot, and until the uniformity of the deposit is proved over considerable areas we cannot view one or two samples as representative of the Nyl Vlei as a whole.

(NOTE.—To the two analyses of Nyl Vlei loams referred to above, supplied by Dr. Marchand, I have added in the following table that of a third sample taken on Zyferkraal, about a mile higher up-stream than his No. 6064, made by Mr. Arthur Stead, B.Sc., F.C.S., in June, 1914, for my son, who at that time was studying under him at the Grootfontein School of Agriculture. It is marked No. 5 and is considerably richer than the other two, particularly in nitrogen, humus and lime.—E.E.G.)

Sample No. . . . .	5	6064	1924
Locality . . . . .	Zyferkraal, 1968, Nyl Vlei, Naboomspruit.	Zyferkraal, 1968, Nyl Vlei, Naboomspruit.	De Brak, 691, Nyl Vlei, Tobias Siding.
Description . . . . .	Dark grey loam.	Dark grey loam.	Dark grey sandy loam.
<i>Chemical Analysis.</i>			
Moisture . . . . .	2.10	1.53	2.36
Loss on ignition . . . . .	7.10	5.06	4.91
Insoluble matter . . . . .	79.00	84.28	76.89
Iron oxide and alumina . . . . .	..	8.32	14.40
Lime . . . . .	0.42	0.26	0.17
Magnesia . . . . .	0.13	0.22	0.16
Potash . . . . .	0.58	0.35	0.34
Phosphoric oxide . . . . .	0.047	0.04	0.05
Nitrogen . . . . .	1.60	0.123	0.088
Available potash . . . . .	..	0.0025	0.0121
Available phosphoric oxide . . . . .	..	0.0032	0.0014

Sample No. 6064 is neutral to litmus, well supplied with nitrogen and potash, but deficient in phosphoric oxide although the percentage of the latter soluble in citric acid is above the average; sample 1924 is similar in character.

#### PHYSICAL PROPERTIES OF THE SPRINGBOK FLATS SOILS.

The relationship of soil to water is largely governed by the texture, to which expression is given in the mechanical analysis.

The other factors which influence this relation are situation and the nature of the subsoil. These factors cannot be determined in the laboratory, but other things being equal a measurement of the water capacity and pore space of a laboratory sample gives a fair indication of the nature of this important relationship. Water capacity, pore space, volume expansion on saturation with water and weight per unit volume have been determined for the sample submitted. These results, together with those for certain other Transvaal soils, are given in the sub-joined table. The pore space and water capacity are dependent on the clay content of the soil to a great extent and are thus complementary to the mechanical analyses. Optimum water conditions are generally taken as about 60 per cent. of the water capacity; rather more in the case of heavy soils, rather less in the case of light sandy soils. The absolute quantity of water required to maintain a soil at optimum conditions for plant growth varies therefore with the class of soil, sandy soils having a much lower water capacity than heavy soils.

Sample No.	Water Capacity.	Pore Space.	Volume Ex-pansion.	Weight per Unit Volume.
6056. Black Turf, Amsterdam ..	72.7	58.2	43.0	1.29
Average for black turf ..	66.7	57.4	37.8	1.32
6057. Chocolate, Turf Pan ..	60.3	55.4	25.4	1.25
6059. Brown Loam, Turf Pan ..	55.1	52.5	24.5	1.29
Average for heavy red soils ..	42.1	49.1	7.2	1.33
6060. Red Sandy Loam, Roodepoort	28.2	38.6	5.7	1.47
6061. Rooibos Veld, Mooihoeks- poort .. .. .	25.9	37.1	2.1	1.48
2060. Red Sandy Loam, Middcl- kopje .. .. .	33.8	42.2	6.1	1.41
Average for Sandy Loams ..	29.4	39.3	3.9	1.44
6062. Sand Veld, Mooihoekspoort ..	21.4	34.4	1.2	1.63
6063. Thomboti Association, Zyfer- kraal .. .. .	23.0	34.8	1.5	1.56
Average for Sandy Soils ..	24.5	35.9	2.0	1.53

With the exception of the heavy red soils Nos. 6057 and 6059, these samples from the Springbok Flats have physical properties in keeping with those of samples of similar mechanical make-up from other parts of the Transvaal as a comparison of the data in the table will show.

The heavy red or chocolate soils of the Flats are, however, somewhat heavier in texture, that is they contain more clay, than the majority of red soils from other localities which we have examined and appear to have properties approaching those of black turf soils, a fact which in all probability is accounted for by the close genetic relationship between these two types.

The samples of heavy red, brown or chocolate soils previously examined have invariably shown a pore space higher in value than the water capacity while for the Springbok Flats soils the water capacity is greater than the pore space. Previous experience has shown the latter to be the invariable rule for black turf. The volume expansion for these samples is far in excess of that found for other heavy red soils and approaches the lowest value found for black turf.

It has been remarked that the relationship between soil type and water conditions may be profoundly modified by the nature of the subsoil. Unfortunately the complete sections underlying these samples are imperfectly known. The black turf is usually homogenous right down to decomposing rock except in certain places where there is a bed of calcareous concretions which usually rests on the decomposing rock. The red and chocolate heavy soils seem to have a similar section.

About the subsoil of the red sandy loams and grey sandy soils very little information is available. Sample No. 6060 is stated to be overlying lim conglomerate and Wybergh (7) states that in a limestone quarry the overburden of red sandy soil or black turf, one to three feet thick, is underlain by a bed of calcareous nodules, from three to six feet thick, passing gradually into a hard and massive limestone which rests upon the amygdaloidal basalt. It is uncertain whether Wybergh refers to the group of soils we have termed "red or chocolate loam" or to the "red sandy loam" when speaking of a "red sandy soil."

(NOTE.—The soil sections underlying sample No. 6060 and the red sandy loams and red heavy loams on Roodepoort No. 1974, generally, are

very uniform in character right down to the calcareous nodules or the decomposed basalt, as the case may be, upon which they rest. When the subsoil is brought to the surface, it is not what is commonly called "dead," that is vegetation will grow freely upon it without its requiring to be first mellowed by exposure to the air and sun, as is frequently the case with other soils. This homogeneity is probably due in great measure to termites, which are very active in this class of soil, as is evidenced by the grains of lime brought to the surface by them in the area underlain by it.

The underlying sections of the grey sandy soils vary in character in different localities and are not generally uniform with the surface soils.—E.E.G.)

The chemical analyses of Mr. Galpin's samples (Nos. 6056 to 6064 and 6080) were carried out by M. F. L. Bischoff and the mechanical analyses by L. Kibel; their assistance in this work is gratefully acknowledged.

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## GENERAL CHARACTER OF THE VEGETATION.

The "Springbok Flats" forms a portion of the "Bushveld Plant Region" one of the nineteen botanical regions into which Dr. I. B. Pole Evans has divided the Union and which he has ably described in his Presidential Address to the South African Association for the Advancement of Science, 1920.

Its general aspect is that of a level plain shut in by mountains on the north and on the west, with the exception of a small southern portion, and bordered on all sides with broad stretches of wooded grassland of the Savannah type in some parts, and wooded sandveld in others. The dominant trees are *Acacias* in the richer soils derived from basalt and species of *Terminalia*, *Burkea*, *Vitex* and *Combretum* in the poor, sandy soils of the sandstone ridges. The central portion, from close to the northern border nearly to the southern one, is practically pure grassland. Across the middle of this grassland, dividing it into northern and southern sections, is stretched a wooded sand belt, six or seven miles wide.

In the deep loose sand of the sand ridges the arboreal vegetation becomes much closer and the trees larger in size, whilst the grass becomes scanty and it ceases to be wooded grassland, but gradually merges into this in the richer parts of the sandveld, where the sand is not so loose and has received some enrichment.

Along the western border the broad submarshy grassy flats of the Nyl Vlei shine conspicuously as an open belt running through the wooded margin of the Flats.

The limiting ecological factors of the vegetation of the Flats as a whole are essentially climatic.

In the first place it has to stand a very heavy rainfall during the summer months, when the soil frequently remains saturated with water for a week or more at a time, the ground being so level that in most places there is no run-off and all rain falling remains to soak in. In the case of the belts of heavy sandveld such saturation does not occur, as no matter how heavy the rainfall may be, it quickly sinks underground through the deep, loose, surface sand.

Following this wet period, comes a long stretch of five or six months of almost rainless weather, during which the soil becomes very dry. This dry period includes the whole of the winter months, during which the vegetation is subjected to intense insolation throughout the hot, cloudless days, followed abruptly by frequent sharp frosts at night, together producing very trying conditions for plant life.

The result is that plants of a Karroid type, though well suited for the dry season, are unable to withstand the heavy summer rainfall, whilst hygrophilous and mesophytic plants, requiring moist or fairly moist conditions, well suited for the summer rainfall period, cannot survive the long dry season, particularly as there is an entire absence of sheltered valleys. The heavy winter frosts further exclude all frost-tender plants.

Another important factor in limiting the character of the vegetation is the annual grass fires to which this area has been subjected during the spring months for an unknown number of years. It is the practice of the aborigines to burn the veld every spring and probably has been for centuries past, as they are extremely conservative and do not readily change their customs. Owing to the absence of all barriers, such as hills and rivers,

a grass fire once started during the windy spring months will sweep over the country for many miles if left unchecked. The grass being frequently two and three feet in height, only trees and shrubs which are more or less fire-resistant have been able to survive.

The vegetation of the Flats is consequently restricted to the following types :—

- (a) Annual : Springing up after the first soaking rains and dying before winter sets in—(Therophytes).
- (b) Bulbous, or with tubers, rhizomes or other underground storage organs—(Geophytes).
- (c) With the entire stem and branches underground, short epigeal shoots only appearing during a part of the year, like *Dichapetalum cymosum* and others—(Cryptophytes).
- (d) With buds at the surface of the ground and a sufficiently strong rootstock to survive after frost, drought or fire has caused the plant to die down to ground level.—(Hemipterophytes).
- (e) Of a very adaptive character and able to stand grass fires, extremes of heat and cold and extremes of wet and dry conditions.—(Both Pyrophytic and Xerophytic).

and in the limited Vlei area—

- (f) Marsh plants, (Helophytes).
- (g) Water plants, (Hydrophytes).

The plant associations vary in accordance with the edaphic conditions and are described in the following chapter.

## PLANT ASSOCIATIONS.

Following the different soil and other edaphic conditions, the indigenous vegetation on the Flats can be grouped into six fairly distinct plant associations. viz. :—

- I. The Black Turf.
- II. The Basaltic Loam.
- III. The Sandveld.
- IV. The Rooibos.
- V. The Thomboti.
- VI. The Vlei.

The above Associations do not include the flora of the narrow belt fringing the southern and eastern borders of the Flats occupied by rocks of the Ecra Series of the Karroo System, as shown by Dr. P. A. Wagner in his geological map and included by him in the chapter on the geology of the Flats kindly contributed to this memoir. It is not looked upon from a farming point of view as forming a portion of the Springbok Flats proper and is not dealt with in my Survey.

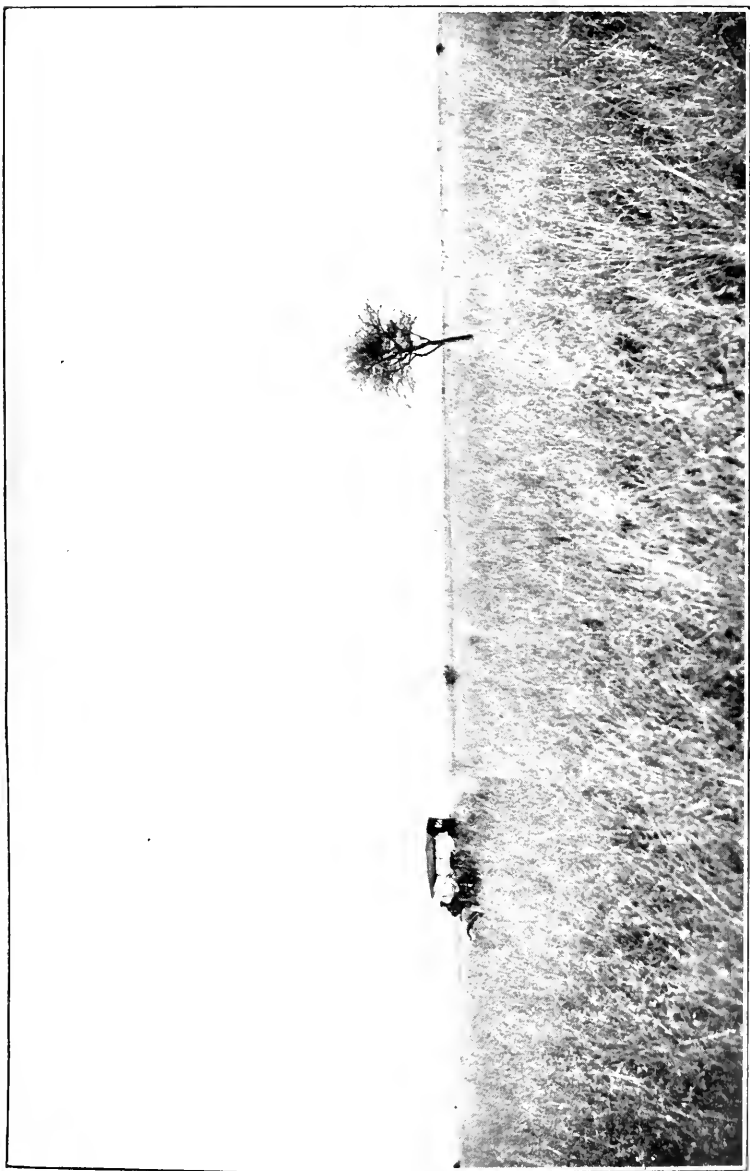
### I. THE BLACK TURF ASSOCIATION.

The "Black Turf" soil as it is popularly called, is derived from the basaltic rocks of the volcanic series of the Karroo System and is found in practically equal proportions with the basaltic, red, heavy loams wherever the soil is derived from the underlying basalt.

These two soils are by far the most important on the Flats and occupy more than half of its area. They alternate in a bewildering manner, apparently without reason. It appears probable that the "black turf" developed where soil drainage was poor or entirely lacking, and the chocolate and red soils on ground where, owing either to an appreciable slope or to fissures or other escapes in the underlying formation, better drainage conditions prevailed. However this may be, in many places there is no visible difference in situation.

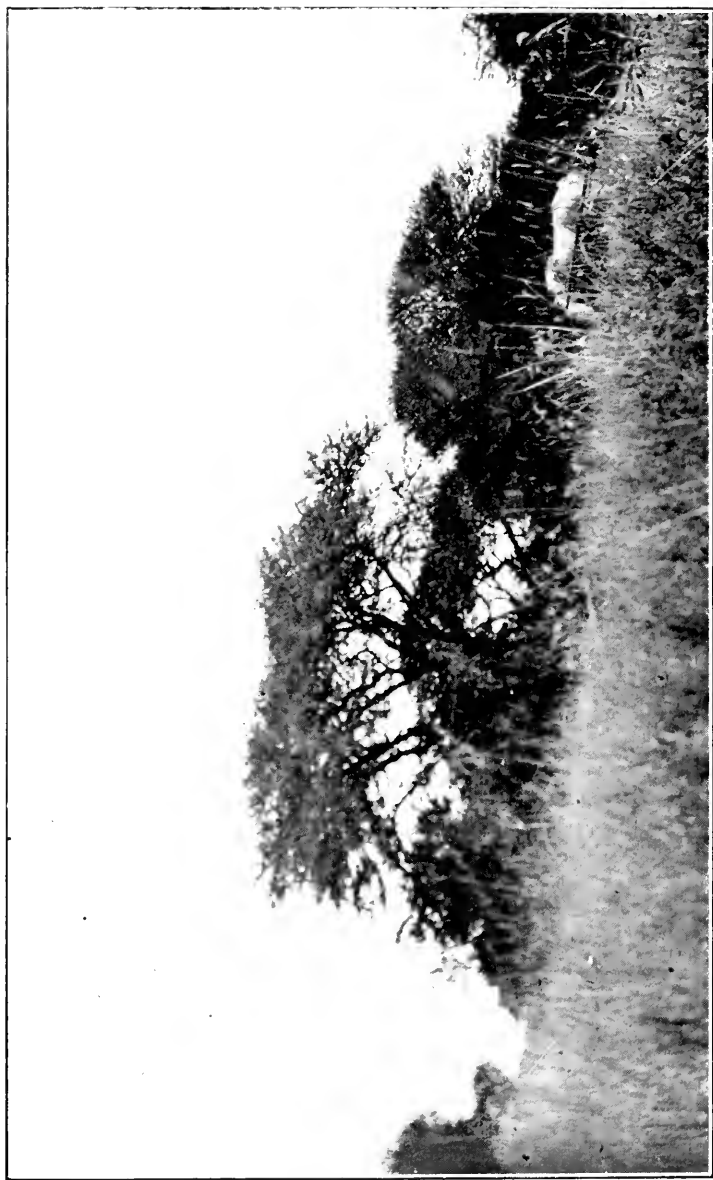
The Black Turf Plant Association is a very distinct one and has many species peculiar to itself. It consists for the greater part of almost pure grassland, generally with small clumps scattered about of either *Acacia permixta*, var. *glabra*, Burt-Davy, or of a stoloniferous variety of *Acacia natalitia*, E. Mey. (Galpin No. M. 528). These two *Acacias* never seem to be found growing together; in some localities the one will be prevalent and in other parts the other. Being of precisely the same habit and of very similar general appearance, they both go under the name of "Fijndoor" and are not recognised by farmers in general as being two distinct species, although bearing legumes of very different shape. Neither of these varieties is known elsewhere and they constitute two very characteristic and noteworthy plants of the black turf, particularly well known owing to the labour necessary for their eradication before the land can be brought under the plough. They do not grow taller than the surrounding grass but have fairly large underground branching stems, which radiate about six inches beneath the surface from a central tap-root. Along these subterranean branches, a number of short, erect branchlets are sent up, which form low thickets in the grass. In the neighbouring basaltic loam association a





Central Grasslands on farm Geluksfontein. Red basaltic loam and black turf soils alternating. In the foreground the basaltic loam association, with its dominant grass, *Themeda triandra* (Rooigras) and a few scattered young pioneer trees of *Acacia* *littoralensis* (Haakenspek). Note the level nature of the ground.

Photo by P. A. Wagner.

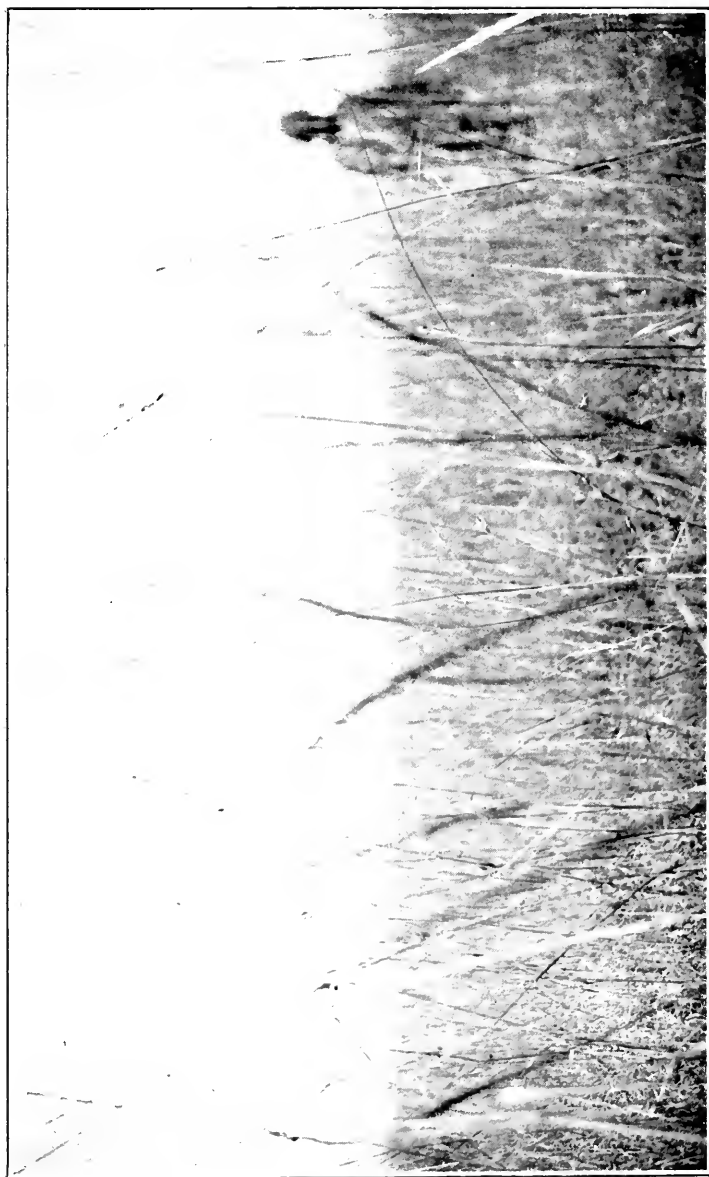


Black Turf Association, Consociation of *Acacia Brachyactis* on farm Belmont (Sjambok's Kopjes). The dominant grass, *Setaria Holstii*, in the foreground.

Photo by E. E. Galpin, 21/5/25.



The Black Turf Association. Consociates of *Sphagnum Holstii*, the dominant grass. On Farm Turfpan.  
Photo by E. E. Gilpin. 21.5.25



The Black Turf Association. Consocius of *Schima Galpinii*. On farm Geluk.

Photo by E. E. Galpin, 21/5/25.

varietal form of *Acacia litakunensis*, Burch. is found in a few places having the same habit and I believe in Bechuanaland *A. stolonifera*, Burch. also has it.

In the black turf in various places along the fringe of the central grassland, and steadily invading it from all sides, are small groves of *Acacia litakunensis*, *A. Benthani*, *A. Gerrardi*, and *A. karroo*, which are usually found in pure stands of a single species. Amidst these are occasional specimens of *Rhus lancea*, *R. pyroides* and *R. Engleri* and young plants springing up of *Zizyphus mucronata*, *Royena pallens* and *Gymnosporia burxifolia*.

Amongst the small herbs and shrublets growing in the grassland, *Sesbania mossambicensis* (Motsuigitsuigi) takes a noteworthy place. It is found in great abundance over large stretches of the black turf, to which it appears to be restricted, and at the end of winter, when dry and good pasturage is scarce, is greedily eaten down to the roots by stock. It is one of the greatest of nitrogen formers and its roots are remarkable for the number of nitrogen nodules on them. I am told that one of the native names for it means "fat mealies" showing their experience to be that where it grows heavy crops of mealies may be expected.

Species of *Rhynchosia* are abundant, particularly one, a small shrub of erect habit (Galpin No. M.586) which appears to be undescribed, and a small trailing species allied to *R. Memnonia*, var. *prostrata* (Galpin No. M.584). Other Leguminosae are: *Indigofera hiliaris*, very abundant throughout the black turf, *Tephrosia lupiniifolia* and *Glycine micans*, Welw?—an abundant and conspicuous plant in certain very restricted localities in the central grassland. *Elephantorrhiza Burchellii*, *Cassia mimosoides*, and *Vigna Burchellii*, *V. triloba* and *V. vexillata*.

Other small plants are: *Commelina krcbsiana*, *Chlorophytum clatum*, *Eriospermum Burchellii*, *Aloe transraalensis*, *Asparagus Burkei*, *Amocharis falcata*, *Gladiolus Elliotii*, *Habenaria foliosa*, *Eulophia aemula*, *Achyranthes aspera*, *Achyropsis leptostachya*, *Pharnaceum verrucosum*, *Tragia incisifolia*, *Jatropha Schlechteri*, *Grewia* n.sp. (Galpin No. M.39), *Sida longipes* and *S. cordifolia*, *Lythrum sagittaeifolium*, *Pachycarpus schinzianus*, *Pentarrhinum insipidum*, *Ipomoea* spp., *Heliotropium Eduardi* and *H. ovalifolium*, *Lantana salicifolia*, *Clerodendron glabrum*, *Salvia* sp. (Galpin No. M.601), *Sutera luteiflora*, *Crabbea* sp. (Galpin No. M.596), *Peristrophe natalensis*, *Vernonia Kraussii* and *Wedelia natalensis*, the latter being particularly abundant in many parts.

The dominant grass is *Setarii Holstii*, which is generally prevalent throughout the black turf, to which it appears to be restricted, and often occurs in consocieties covering large areas. It is but a poor pasture grass and fortunately under closer settlement tends to be replaced by other grasses of superior quality.

Other abundant grasses, restricted to the black turf association and locally dominant in many places, are: *Ischaemum glaucostachyum*, which comes next in frequency to *Setaria Holstii* and is a rather coarse grass with a very strong and extensive root system, producing many stout stoles, which make ploughing difficult, but are excellent as suppliers of humus when ploughed in; *Setaria Galpinii*, of which there are considerable consocieties on the farms Geluk, Zandfonteinsoog and Haakdoornbult, is remarkable as being the only known occurrence of a grass of this genus in South Africa and produces very stout culms useful for thatching; *Sorghum versicolor*, a particularly valuable pasture grass, very fattening and greedily eaten to the ground by stock even when dry, is found in fair abundance over a wide area: *Amphilophis insculpta*, a good pasture grass, dominant on moist places.

The following excellent pasture grasses, not confined to the black turf association, are found in fair abundance :— *Pennisetum cenchroides* (Lidjesgras), which owing to its branching habit is particularly valuable since new branches are continually being formed thus supplying a succession of green and very palatable food ; *Themeda triandra*, the very widely distributed “ Rooigras,” a good fodder plant, noted for its resistance to frost and drought, *Eragrostis superba*, *Digitaria eriantha*, *Fingerhuthia africana*, *Urochloa pullulans*, var. *mossambicensis*, *Urochloa trichopus*, *Echinochloa Holubii*, *Panicum minus*, var. *planifolium*, and *Panicum coloratum*.

Other grasses are : *Amphilophis glabra*, *Dichanthium annulatum*, *Urochloa helopus*, *Brachiaria* sp. (Galpin No. M.702), *Panicum obscurans*, *Panicum* n.sp. (Galpin No. M.547), *Xyochlaena monachne*, *Setaria Gerrardii*, *Aristida adscensionis*, *Enneapogon brachystachyus* and *Diplachne fusca*.

**Ruderal Grasses.**—The chief and most abundant ruderal grass is *Chloris virgata* (Sweet Hay) excellent for hay-making. Others are *Tragus racemosus*, *Brachiaria Isachne*, *Cynodon Dactylon*, *Dinebra arabica*, *Eragrostis major* and *E. aspera*.

**Ruderal Weeds.**—Common in lands and waste places are : *Cyperus rotundus* (Uintje), *Alternanthera Achyrantha* (Khakibos) *Boerhaavia pentandra*, *Orygia decumbens*, *Phyllanthus maderaspatensis*, *Acalypha segetalis*, *Corchorus asplenifolius* and *C. trilocularis*, *Hibiscus Trionum*, *Waltheria indica*, *Ionidium enneaspermum*, *Ipomoea* sp.p., *Leucas martinicensis*, *Withania somnifera*, *Physalis minima* (Gooseberry), *Solanum panduraeforme* (Poison Apple), *Datura Stramonium* (Stinkblaar), *Striga Forbesii*, *S. orobanchoides*, and *S. lutea* (Rooibloem or Witchweed), *Ceratotheca triloba*, *Vernonia steeziana*, *Nidorella resedaefolia*, *Zanthium strumarium* (Cocklebur), *Bidens pilosa* (Black Jack), *Senecio* sp. (Galpin No. M.529) and *Tripteris flexuosa*.

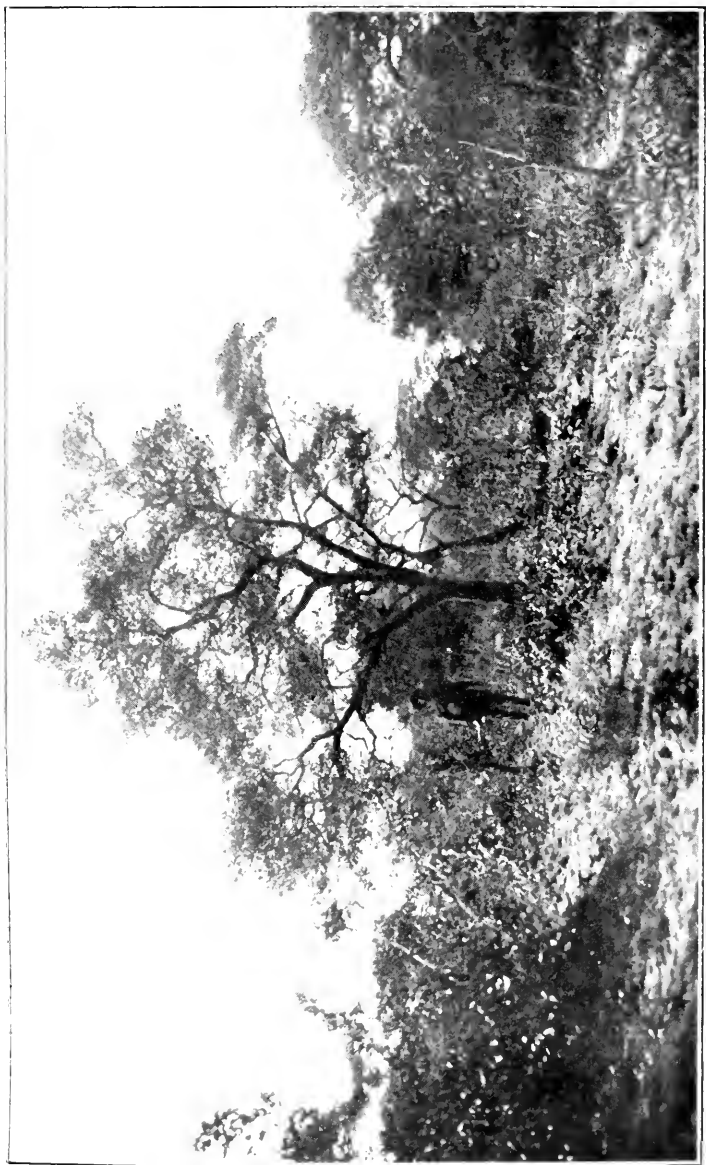
The most abundant and distinctive weed of the black turf is a species of *Ipomoea* (Galpin No. M.530) bearing very small white flowers, which is not described in the Flora Capensis and may be a new species. It appears to come up in practically every black turf land, no matter how well cultivated. *Bidens pilosa* is also a very common weed and apt to overgrow neglected lands.

## II. THE BASALTIC LOAM ASSOCIATION.

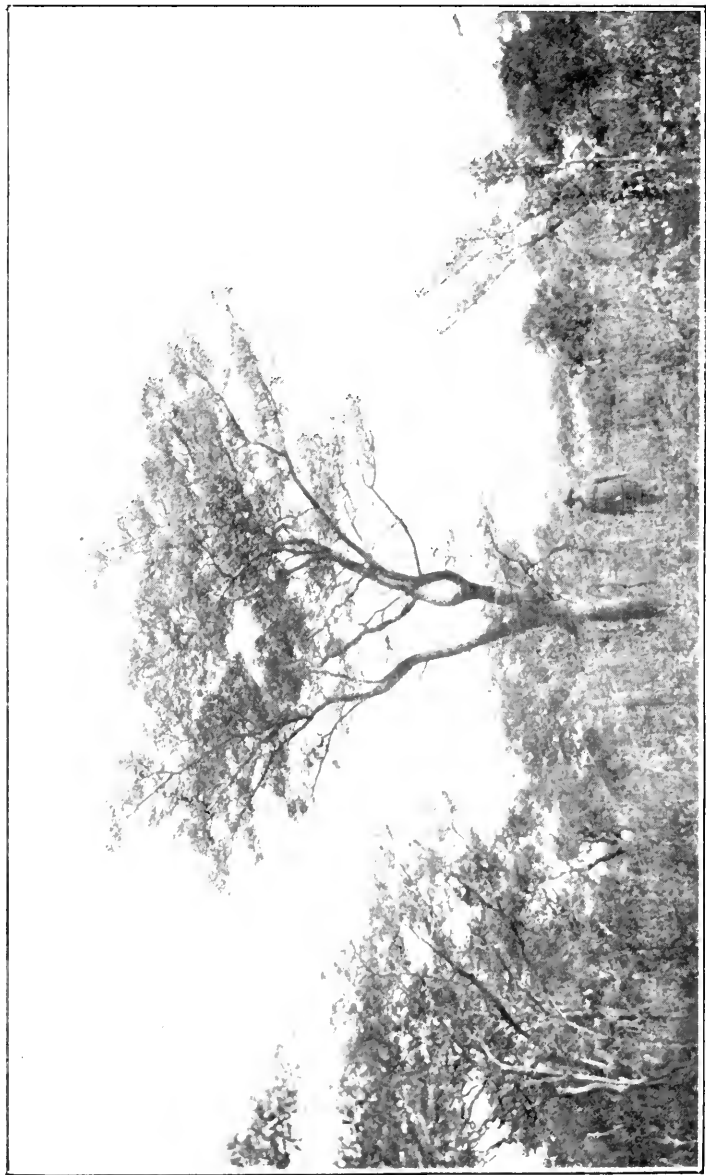
As already mentioned, this alternates with the Black Turf Association, in the way described under the latter heading, throughout the length and breadth of the Flats and constitutes the Flora of the basaltic red heavy loams, which vary in colour from bright red to chocolate. Under cultivation the same land will vary in colour from bright red to dark brown according to the exposure of the ploughed land to the sun, which reddens it, or to whether a crop has been recently ploughed in, which darkens it. In this manner a change in colour can be effected in a single season. The soil is deep, fertile and well supplied with lime.

Although a large area occupied by it in the central portion of the Flats is treeless and practically pure grassland, it is a typical *Acacia* veld. *Acacias* are everywhere the dominant tree and are everywhere invading the central grasslands from all sides. It is only a question of a few decades when they will dominate the whole area.

Its typical aspect is that of a flat grassland, with long waving grass, interspersed with trees and shrubs for the most part growing solitarily. in some parts sparsely scattered about and in others more densely, with here and there small clumps of mixed trees and shrubs closely aggregated.



Sandveld Association. Wooded heavy sandveld, with *Styphaneis pumilus* in the foreground. On farm Voordel.  
Photo by F. E. Galpin. 287424.



Savanna vegetation. Wooded heavy woodland, with *Balanites* in the foreground. On farm Wooded.  
Photo by E. E. Gidson, 28/5/24.





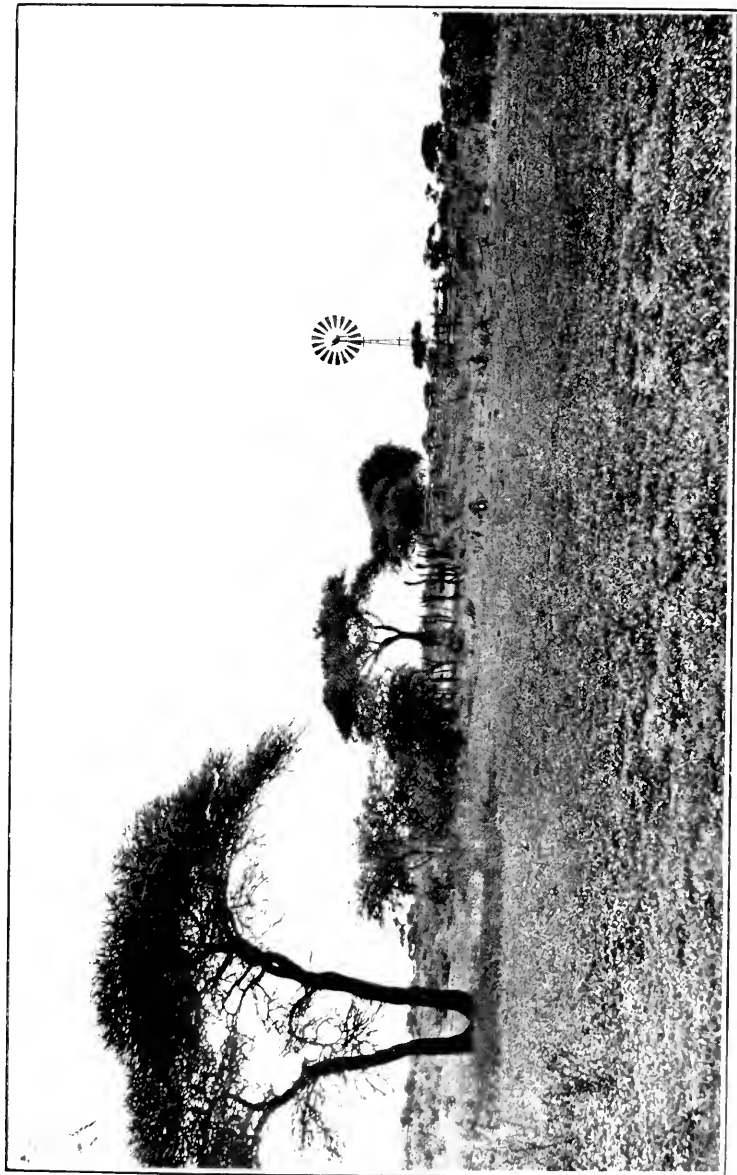
Typical Kopje of Bushveld Sandstone on Farm Klippout.

*Photo by E. E. Gollins, 15.6.25.*

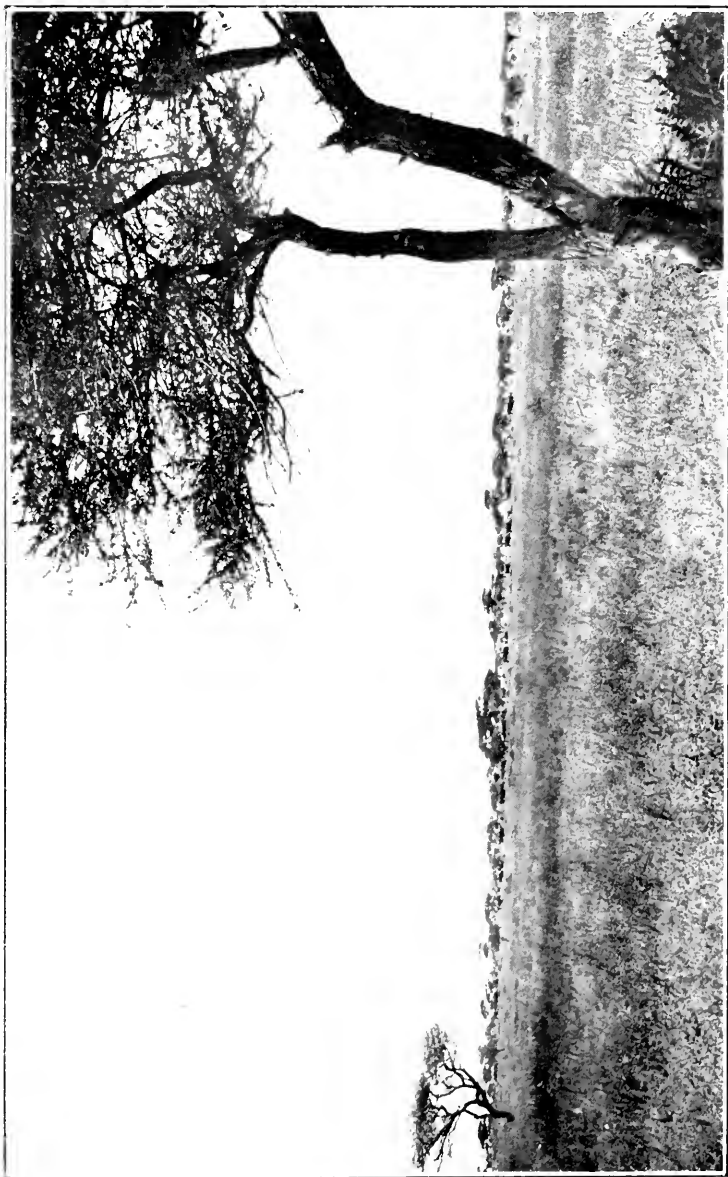


*Cucumis hamifractus*, Stent, raised from seed at Mosdene

Photo by H. H. Storing, Feb., 1926.



The Southern Flats View two miles north of Timpahute Station. On basaltic rock.  
*Photo by Dr. P. A. Wagner*

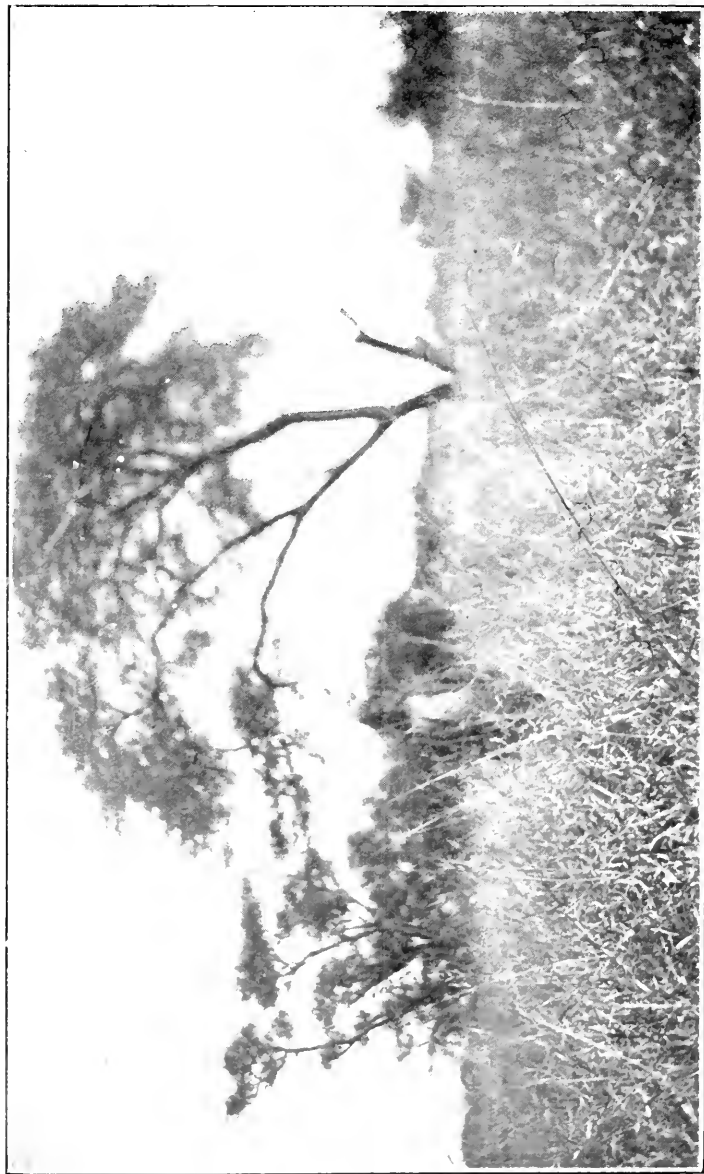


The Southern Flats. View three miles east-north-east of Codrington Siding. On basaltic rocks.  
*Photo by Dr. P. A. Wagner.*



The *Thom's* tree, also as *Thom's* tree, the dominant tree, with *Acacia* in the background.  
On farm Rooftop.

Photo by F. F. Giblin, 1965



The Basaltic Loam Association. Consociates of *Cratogeomys*, n. sp. (Galpin, No. M673). In the background - *Yucca baccata*, *Rhus*  
*Engelm.*, *Frax* and *Frax* *hololeuca*. On left *Cratogeomys*.

Photo by E. E. Galpin, 12.6.25.

The tall, flat-topped *Acacia litakunensis* (Haakensteekdoorn) is a conspicuous feature in the vegetation. *Acacia karroo* (Sweet thorn) is equally abundant. The great number of very young trees and absence of old ones shows this species to be a comparatively recent and most aggressive arrival. Next in frequency comes *Dichrostachys nutans* (Sikkelbos). *Acacia robusta* (Oudoorn or Engelschedoorn), *Acacia Gerrardi* (Aapkop), *Acacia retinens* (Galpin No. M.114, Zwarthaak), whilst not uncommon, are more local. *Acacia giraffae* (Kameeldoorn) and *Acacia hebeclada* are rare.

*Acacia karroo* and *Dichrostachys nutans* are more frequently seen standing alone or in unmixed groves, whilst the other acacias are usually found in small clumps of mixed bush.

Other trees are : *Peltophorum africanum* (locally called either "Kajatenhout," a name applied in the Low Veld to *Pterocarpus erinaceus*, or "Huilibos," which is also and far more appropriately applied to *Schotia brachypetala* on account of the fluid which its flowers exude giving the appearance of weeping), *Spirostachys africanus* (Thomboti), *Zizyphus mucronata* (Blinkblaar wachteenbietje), *Combretum rhodesiacum* (Kerrieklapper), *Olea verrucosa* (Olivenhout), *Pappea fulva* (Lobengula's indaba tree), *Boscia rehmanniana* (Witgat or Wonderboom), *Euclea undulata* (Guarri), *Gymnosporia buxifolia* (Pendooorn), and *Salacia? transvaalensis* (Lepelhout).

The most abundant of the shrubby plants are : *Rhus Engleri*, *Grewia* n. sp.? (Galpin No. M.39), *Carissa arduina*, *Ehretia hottentotica*, *Gymnosporia* sp. (Galpin No. M.55, a very thorny, low growing plant, possibly a varietal form of *G. buxifolia*) and *Rhoicissus cuneifolia*. These are to be found in most bush clumps.

As the bush clumps form so important a feature of this association, the following list of the individual components of a few typical bush clumps on the farm Roodepoort, from actual survey, will be of interest.

Bush clump (a) area 20 by 20 yards :—*Acacia litakunensis*, *A. robusta*, *A. karroo*, *Rhus Engleri*, *R. lancea*, *Ehretia hottentotica*, *Euclea lanceolata*, *Boscia rehmanniana*, *Gymnosporia buxifolia*, *G. sp.* (Galpin No. M.55), *Tarchonanthus camphoratus*, *Combretum rhodesiacum*, *Carissa arduina*, *Asparagus Cooperi*, *A. africanus*, *Cissus lanigera*, *Paronia macrophylla*, *Pupalia lappacea*, *Aloe transvaalensis*, *Panicum maximum*, *Pennisetum cenchroides*.

Bush clump (b) area 18 by 18 yards :—*Dichrostachys nutans*, *Acacia karroo*, *Gymnosporia buxifolia*, *Rhus Engleri*, *Grewia* n. sp.? (Galpin No. M. 39), *Tarchonanthus camphoratus*, *Carissa arduina*, *Asparagus africanus*, *Barleria Mackenii*, *Achyranthes aspera*, *Panicum maximum*.

Bush clump (c) area 12 by 10 yards :—*Peltophorum africanum*, *Acacia litakunensis*, *A. robusta*, *Combretum rhodesiacum*, *Gymnosporia buxifolia*, *Royena pallens*, *Rhus pyroides*, *Solanum* sp. (Galpin No. M. 245), *Asparagus africanus*, *Lantana salvifolia*, *Crabbea hirsuta*, *Panicum maximum*.

Bush clump (d) area 9 by 9 yards :—*Acacia litakunensis*, *A. karroo*, with *Loranthus Zeyheri*, *Zizyphus mucronata*, with *Viscum rotundifolium*, *Gymnosporia buxifolia*, *G. sp.* (Galpin No. M. 55), *Grewia* n. sp.? (Galpin No. M. 39), *Euclea lanceolata*, *Carissa arduina*, *Rhoicissus cuneifolia*, *Royena pallens*, *Lantana salvifolia*, *Asparagus Cooperi*, *Corchorus asplenifolius*, *Thunbergia drceana*, *Cymbopogon excaratus*, *Enneapogon scoparius*.

Bush clump (e) area 12 by 12 yards :—*Acacia litakunensis*, *A. robusta*, *Rhus Engleri*, *Grewia* n.sp.? (Galpin No. M.39), *Gymnosporia*, sp. (Galpin No. M.55), *Carissa arduina*, *Cissus lanigera*, *Solanum* sp. (Galpin No.

M.245), *Asparagus africanus*, *Hibiscus calycinus*, *Ruellia ovata*, *Lapeyrousia grandiflora*, *Commelina krebsiana*, *Xyochlaena* n. sp.? (Galpin No. M.404), *Eragrostis lehmanniana*, *E. biflora*.

**Herbs and Shrubs.**—The commonest of these are: *Commelina albenscens*, *C. krebsiana*, *Cyanotis nodiflora*, *Anthericum* spp., *Eriosperrum* spp., *Scilla* spp., *Asparagus* spp., *Hypoxis costata*, *Talinum caffrum*, *Elephantorrhiza Burchellii*, *Cassia obovata*, *Indigofera* spp., *Rhynchosia* spp., *Monsonia biflora*, *Tragia dioica*, *Jatropha Zeyheri*, *Cissus lanigera*, *Corchorus asplenifolius*, *Abutilon sonneratianum*, *Sida* spp., *Hibiscus pusillus*, *Ipcmoea* spp., *Lippia asperifolia*, *Clerodendron ternatum*, *solanum* spp., *Aptosimum elongatum*, *Sutera pinnatifida*, *Striga* spp., *Thunbergia atriplicifolia*, *Ruellia ovata*, *Crabbea hirsuta*, *Justicia flava*, *Oldenlandia* spp., *Kedrostis foetidissima*, *Citrullus* spp., *Cucumis* spp., *Trochomeria* spp., *Vernonia Kraussii*, *V. fastigiata* and *Tarchonanthus camphoratus*.

Others are: *Chlorophytum elatum*, *Aloc transvaalensis*, *Albuca* spp., *Urginea altissima*, *Dipadi* spp., *Testudinaria sylvatica*, *Gladiolus edulis*, *Lapeyrousia grandiflora*, *Habenaria foliosa*, *H. bonatea*, *Eulophia* spp., *Loranthus Zeyheri*, *Viscum rotundifolium*, *Thesium gracilaroides*, *Sericorema remotiflora*, *Pupalia lappacea*, *Pollichia campestris*, *Antizoma harveyana*, *Polanisia* spp., *Kalanchoe rotundifolia*, *K. glandulosa*, var. *tomentosa*, *K. sp.* near *K. pyramidalis* (Galpin No. M. 620), *Tephrosia* spp., *Polygala* spp., *Euphorbia* spp., *Corchorus serraefolia*, *Pavonia* spp., *Gossypium herbaceum*, *Melhania* sp., *Hernannia* spp., *Adenia multifida*, *Heteromorpha arborescens*, *Royena pallens*, *Raphionacme divaricata*, *R. Burkei*, *Asclepias* spp., *Cerepegia* spp., *Caralluma lutea*, *Evolvulus alsinoides*, *Ehretia caerulea*, *Trichodesma angustifolium*, *T. physaloides*, *Lantana salvifolia*, *Lippia scaberrima*, *Bouchea hederacea*, *Harpagophytum Peglerae*, *Thunbergia dregeana*, *Barleria Mackenii*, *Pavetta assimilis*, *Anthospermum decumbens*, *Felicia muricata*, var. *fascicularis*, and *Diconia macrocephala*.

**Grasses.**—Owing to the abundance of palatable and rich grasses, the basaltic loam affords the best pasturage of all the associations excepting the vlei.

The dominant grass is *Themeda triandra* (Rooigras), an excellent pasture grass and one of the most resistant to drought and frost. Next in abundance and locally dominant in many places are: *Digitaria eriantha* (Vingergras) and *Eragrostis superba*, both good sweet grasses, well liked by stock. Even the coarse-looking spikelets of the latter are greedily eaten. *Digitaria eriantha*, with its vigorous stoloniferous habit, is an excellent pioneer grass and one of the first to establish itself in vacant land of the lighter type.

Eupanicaceae, a subtribe embracing many of the most valuable of fodder grasses, are particularly abundant in this association. They include *Panicum maximum* (Buffels gras or Guinea grass), *Urochloa* n.sp. (Galpin No. M. 673) and *Urochloa trichopus*, all of which are noted for their palatability and fattening properties and are sought out by stock and eaten to the ground, even when frosted and quite dry. They grow in fair abundance in small, but very dense, consociates surrounding the trunks of *Acacia* trees. On cutting down the latter and placing the ground under cultivation, these species tend to spread in the open land and to occupy increased areas as ruderals thus improving the pasturage. In the open veld *Brachiaria serrata* and *B. nigropedata*, close allies of the above and of good feeding value, are frequent, whilst *Pennisetum cenchroides* (Lidjesgras), referred to under the Black Turf Association, is not uncommon.

Other grasses are *Cymbopogon excavatus*, *Hyparrhenia filipendula*, *Heteropogon contortus*, *Antheophora pubescens*, *Echinochloa Holubii*, *Panicum*



*coloratum*, *Digitaria argyragrapt* and *D. setivalva*, *Tricholaena rosea*, *Xyochlaena* n.sp.? (Galpin No. M.404), *Aristida barbicollis*, *A. congesta* and *A. sieberiana*, *Sporobolus festivus*, var. *stuppeus*, *Chloris petraea*, *Dactyloctenium aegyptiacum*, *Crossotropis grandiglumis*, *Eruca pagon scoparius*, *Schmidtia bulbosa* and *Eragrostis* spp.

**Ruderal Grasses.**—*Chloris virgata* (Sweet hay) is the most widely dominant grass in the neighbourhood of cultivated lands. It is very palatable and makes an excellent hay if cut in the flowering stage, but has a very short season and dies down early in the autumn. Tramped out ground around homesteads, old native kraals and abandoned lands are frequently dominated by *Cynodon Dactylon*, the well known "kweek", particularly in the more sandy soils, and affords excellent pasture until the advent of the first frost. In moister and richer soils *Eleusine indica* is widely spread as a ruderal and forms a dense carpet of succulent grass, whilst *Setaria imberbis*, a good grass, is found in small consocieties in moist places in a few localities. *Urochloa* n. sp., (Galpin No. M. 673) and *Panicum laevifolium* (indigenous in the "Vlei" Association and known in common with other Panicums as Buffels gras) are dominant as ruderals over considerable areas and are the most valuable hay grasses I know, yielding very large quantities of very palatable fodder of high feeding value and are well worth cultivation. Other ruderals yielding good feeding for stock are *Pennisetum cenchroides*, *Urochloa trichopus*, *Panicum coloratum* and *Brachiaria Isachne*. Ruderals of no special value are *Eragrostis major*, *E. aspera* and *Aristida scabrivalvis*. *Tragus racemosus* (carrot-seed grass) a worthless weed, is common in bare places.

**Ruderal Weeds.**—By far the most abundant and widely spread weeds in cultivated lands are *Spermacoce Rueliae*, which comes up in enormous numbers, and to a lesser extent, *Oldenlandia* spp. Fortunately, both of these are of very small growth, are easily eradicated and do little harm.

*Nidorella resedaefolia*, which previously was only an occasional plant, in 1925 suddenly sprang up in enormous numbers all over the district and took complete possession of many lands of both heavy loam and light sandy loam. It was in full flower and shedding seed before the advent of the spring rains enabled farmers to plough it out, giving heavy work owing to its vigorous growth. The very sudden increase of this weed is probably due to the fact that abundant rains the previous summer made the lands too wet to be cultivated so that weeds made vigorous growth unchecked and seeded freely.

*Striga lutea*.—(Rooibloem or Witchweed), parasitic on the roots of gramineae, is very destructive to maize plants, the principal crop grown on the Flats, and if unchecked will in a few seasons render any further maize crops grown on such land unprofitable, if it be other than black turf, in which difficulties in germination keep it in check. There is evidently something toxic about this plant. The mere withdrawal from the host plant of sufficient nutriment for its very small growth could not otherwise produce such injurious results. Its seed is very minute, is produced in enormous quantity and in all probability is spread from farm to farm by threshing machines. It has great vitality and will germinate after lying dormant in the ground for several seasons. The best checks are constant change of crops and the hoeing out of all plants before they set seeds. As a general rule the latter can be effectively done by going through the mealie lands twice every season, the first time when the most advanced of the *Striga* plants are in full flower and again about a month later. In the case of a land already heavily infected, the best plan is to plant a thick crop of tefl, Sudan grass or boer manna, so as to cause the germination of as many of the *Striga* seeds in the soil as possible, since the seeds of this root parasite will only

germinate in close proximity to a grass plant. Then, when the *Striga* plants come into flower, either reap the crop and plough the stubble under, or plough in the whole crop as green manure. This must be scrupulously followed up by the eradication of all *Striga* plants coming up in after seasons or there will be a repetition of the trouble.

Other common weeds in lands are : *Cucumis myriocarpus* and *C. hirsutus*, *Citrullus* sp., *Lagenaria* sp., *Trochomeria macrocarpa*, *Ipomoea crassipes*, *I. obscura*, *I. ovata* and *I. sp.* (Galpin No. M. 743), *Bidens pilosa* (Black Jack), *Amarantus paniculatus* and *A. Thunbergii* (Pigweed), *Blumea gariepina*, *Erigeron canadense*, *Senecio rhyncholaenus*, *Helichrysum argyrosphaerum*, *Solanum panduriforme*, *Crotalaria lotoides*, *Cassia obovata*, *Corchorus asplenifolius* and *Lepidium capense*.

In waste places *Schkuhria bonariensis*, *Tagetes minuta* (Marigold), *Physalis minima* (Gooseberry) and *Leucus martinicensis* are abundant, whilst tramped out places are apt to be overgrown with *Alternanthera Achyrantha* (Khakibos) and *Gomphrena globosa*.

Other weeds of lesser frequency are *Cyperus rotundus*, *Chenopodium* sp.p., *Portulaca oleracea* and *P. quadrifida*, *Gynandropsis pentaphylla*, *Polanisia* sp.p, *Monsonia biflora*, *Oxalis corniculata*, *Tribulus terrestris*, *Phyllanthus maderaspatensis*, *Euphorbia* spp., *Hibiscus Trionum*, *Datura Stramonium* and *D. ferox*, *Xanthium spinosum*, *Senecio* sp., (Galpin No. M.529), *Tripteris flexuosa* and *Sonchus oleraceus*.

### III. THE SANDVELD ASSOCIATION.

The light grey sandy soil found in the area occupied by the Bushveld Sandstone is for the most part of great depth, but acid and of very poor fertility. In its typical form it is very loose on the surface and looks as if were composed almost purely of fine sand. Its vegetation is very markedly distinct from that of the basaltic loam and black turf. Excepting on a few ridges, where the soil is shallow, open places are of small extent, and it is for the most part heavily wooded with fine trees, whilst grass is scanty and of poor grazing value.

Acacias, which are so marked a feature in the basaltic soils, are entirely absent in the typical heavy sand of the sandveld and are only found in places where it has received some enrichment. The dominant trees in it are *Terminalia sericea* (Vaalbos) and *Burkea africana* (Sering). Other common trees are : *Vitex* sp. (Galpin No. M. 282 Pypsteel), *Ochna pulchra* (Zecrbos), which by some farmers is mistakenly thought to be poisonous to stock, but farmers and natives on Sandveld farms in my neighbourhood scout the idea and graze stock freely upon it, with none but good results, *Strychnos pungens* and *S. schumanniana* (wild orange or klapper), *Securidaca longipedunculata* (Krinkhout or Tree violet), *Dombeya rotundifolia* (Drolpeer), *Combretum Zeyheri* (Nicholaas Klapper or Raasbos) and *C. Gueinzii*.

Other typical trees of the poorest Sandveld, but somewhat less frequent, are *Lannea discolor* (Dikbast) and *Zizyphus mucronata*, var. *pubescens*, a thornless variety of Blinkblaar wachteenbietje.

In localities where the grey sandy soil is somewhat more fertile, *Acacia Burkei* (knopjesdoorn) and *A. caffra*, (Kafir wachteenbietje) *Peltophorum africanum* (Kajatenhout), *Cussonia natalensis* (Nooisboom), *Fluggia macrocarpa*, *Spirostachys africanus* (Thomboti) and *Rhus Gueinzii* (Bastard Karree) are fairly frequent. With further enrichment *Olea verrucosa* (wild Olive) *Acacia karroo* (Sweet Thorn) and *Dichrostachys nutans* appear. The latter tree is looked upon as indicating the best soil of this class and in it often forms dense thickets.

On rocky ridges and in shallow soil the ground is more open and *Faurea saligna* (Bockenhout) is the dominant tree. Associated with it in some localities are the shrubs *Chrysophyllum magalismontanum* (Stamvruchtje), *Protea hirta* and *Barbacenia retinervis*.

*Ficus Soldanella* and *F. cordata* are frequent amongst rocks on the kopjes, whilst in deep sandy soil along the northern border of the Flats there are fine specimens of *Ficus capensis* and other species.

The following are typical Sandveld shrubs: *Grewia caffra*, which is abundant and widely distributed, *Bauhinia macrantha* and *Rhamnus zeyheriana*, small but dense consociates of both of which are abundant: *Mundulea suberosa*, *Vangueria infausta* (Wild Medlar), *Ximenia americana* (Sour Plum), the abundant fruits of which have large soft kernels, yielding 40 to 50 per cent. of oil, and may prove of economic value and become worthy of cultivation; *Cryptolepis oblongifolia*, *Clerodendron glabrum*, *Lanea edulis*, *Heeria salicina*, *Euclea multiflora* and *E. sp.* (Galpin No. M. 632), *Sphedannocarpus pruriens*, *Clematis brachiata* and *Pentarrhinum insipidum*.

Of the smaller shrublets and herbs the most abundant is *Parinarium capense* (Gruisappel), a dwarf shrub, 3 to 6 inches high, having stout underground stems and bearing an edible fruit, which grows in the poorest soil and forms large consociates.

*Dichapetalum cymosum*, the dreaded, poisonous "Giftblaar," occurs in a few places, in small patches, here and there, in heavy sand, but is not nearly so frequent on the Flats as in the hills to the west. It has been stated that this plant is usually associated with *Burkea africana* (Sering) but I can find no justification for this statement beyond the fact that they are both denizens of the heavy Sandveld. One frequently finds large groves of *Burkea* with no *Dichapetalum* in the neighbourhood and patches of *Dichapetalum* with no *Burkea* trees anywhere near.

*Cucumis humifructus*.—An exceedingly rare and unique cucurbitaceous plant (Galpin No. M.146) provisionally named *Cucumis humifructus*, by Miss Stent, but as yet undescribed,\* deserves special mention. It is a monoeceous trailing plant of very ordinary appearance, looking much like that of an ordinary cucumber, bearing clusters of very small yellow flowers, some male and others female, accompanied by long filiform bracts, in the axils of the leaves. After the female flower has been pollinated and the corolla and calyx have withered up, leaving the small conical ovary bare, the stalk carrying it elongates and arching over gradually penetrates the ground to a depth of about nine inches where the fruit, which is a small globular gourd having a parchment-like skin, develops and ripens. It thus has the very singular and rare habit of ripening its fruit underground in the same way as the well-known monkey nut (*Arachis hypogaea*). The penetration of the ovary stipe underground is only noticeable in the living plant upon very close examination, and even if noticed the stipes would probably be taken for axillary rootlets unless pulled out. In February, 1919, I collected specimens of this plant growing in the Sandveld on Roodepoort, but the flowers were all too young to exhibit any signs of a hypogeal fruiting habit and their connection with the gourd previously ploughed up was not discovered. The fact of the existence of a cucurbitaceous plant with this habit was first discovered by the turning up of one of the gourds by the plough in the course of bringing a piece of virgin ground under cultivation long after the plant bearing it had dried up and disappeared. Seeds from it failed to germinate and the plant itself remained unknown for many years till another gourd was ploughed up at Mosdene in the same way and plants

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\* Since described, with illustrations, under the above name, by Miss Stent in *Bothalia*, Vol. II, p. 356. (March, 1927).

reared from its seed by Miss Stent, in Pretoria, on the premises of the Division of Botany, in 1925, and during the 1926 season by myself at Mosdene. By showing these to some 30 natives resident on the Mosdene estate and offering rewards to any who discovered wild specimens, a diligent search was made of the whole neighbourhood which resulted in the discovery of two plants growing on the farm Zyferkraal. Both of these are in the Sandveld, and both are growing at the entrance of antbear holes in the loose soil excavated from them by the antbears. A very intelligent and old Shangaan living on Zyferkraal knows the plant and states that it only grows near antbear holes and that, with the ingrained idea they all have that any strange plant must make strong medicine, they have practically exterminated it in the past for that purpose and also that the destruction of antbears has contributed to make the plant still more rare. He adds that the dried dung of the antbears is used by his people for medicinal purposes and that the humo-fructus gourds are found by them when digging up the loose soil at the entrance to antbear holes, in which the dried dung is always found, to collect it. The gourd from the seed of which the plants were raised was ploughed up in newly cleared land in basaltic loam on Roodepoort and brought to me as being a very uncommon and peculiar tuber which it much resembles. I did not at the time connect it with antbear holes: there certainly was an antbear hole in the land which was cleared, but whether or not the gourd was ploughed up on the spot occupied by it cannot be ascertained. It is in the centre of a large ploughed field with no landmarks to fix the spot. There is thus up to the present no evidence to contradict the native belief that the plant only grows in the material excavated from antbear holes.

In wooded heavy sandveld *Clematis Stanleyi*, *Cassia absus*, *Oxalis convexula*, *Hibiscus physaloides*, *Triumphetta* sp. (Galpin, No. M42). *Pachystigma Cienkowski*, bearing pleasant tasting edible fruit are abundant. Somewhat less frequent are *Bulbine tortuosa*, *Asparagus Burkei*, *Scilla* spp., *Viscum rotundifolium*, *Crassula nodulosa*, *Pelargonium aconitophyllum*, *Hermannia Woodii*, *Merremia palmata*, *Ipomoea* spp., *Teucrium capense*, *Justicia Bowiei*, *Vernonia steetziana*, *Tarchonanthus camphoratus*, *Senecio latifolius* and *S. orbicularis*.

Frequenting the more open sandy places, the most abundant shrublets and herbs are: *Vahlia capensis*, *Menodora africana*, *Indigofera sordida* and *I. oxytropis*, the latter a particularly handsome plant, with beautiful silvery foliage and showy flowers of a clear pink; *Zizyphus zeyheriana*, growing in dense consociates; *Triumphetta trichocarpa*, *Cucumis* spp., *Selago hermannioides*. *Oldenlandia chlorophylla*, *O. caffra* and *O. Heynei*, *Gladiolus Elliotii*, *Microtea tenuissima*, *Limeum fenestratum* and *L. viscosum*, *Giesekia pharnaceoides*, *Cleome maculata*, *Elephantorrhiza Burchellii*, *Tephrosia* spp., *Rhynchosia* spp., *Eriosema oblongum*, *Bergia decumbens*, *Petrea zanguibarica*, *Harpagophytum Peglerae*, *Barleria macrostegia* and *B. sp.* (Galpin No. M272), *Blepharis molluginifolia*, *Pachystigma Zeyheri*—a small plant, only a few inches high, having stout underground branching stems, occurring in small patches, in dense consociates, and bearing delicious edible fruit: it is closely related to the poisonous Highveld plant, *Pachystigma pygmaea*, but is harmless to stock—*Vernonia steetziana* and *V. Kraussii*, and *Dicoma anomala*.

Less frequent and occasional are: *Cyperus marginatus* and *C. sphaerospermus*, *Bulbostylis capillaris*, *Buphane toxicaria*, *Ammocharis falcata*, *Hypoxis costata*, *Babiana Bainesii*, *Thesium junceum*, *Hermbstaedtia elegans*, *Cyphocarpa angustifolia*, *Aerva leucura*, *Portulaca pilosa*, *Cassia mimosoides*, *Crotalaria laburnifolia* and *C. nubica*, *Acalypha* sp. (Galpin No. 322),

*Salacia Rehmannii*, *Waltheria indica*, *Hermannia boraginiflora*, *Convolvulus hastatus*, *Lippia asperifolia*, *Orthosiphon affinis*, *Acrotome inflata*, *Melasma* spp., *Thunbergia atriplicifolia*, *Crabbea hirsuta*, *Blepharis squarrosa*, *Crossandra Greenstockii*, bearing handsome vivid scarlet flowers; *Justicia anagalloides* and *J. pulegioides*, *Scabiosa columbaria*, *Helichrysum nudifolium* and *Dicoma macrocephala*.

In moist places around the margins of pans are dense associates of *Wahlenbergia undulata*, *Lobelia decipiens* and *L. Erinus*; *Listia heterophylla*, *Selago* sp. (Galpin No. M.768), and *Portulaca* sp. (Galpin, No. M.150). After the early summer rains, the brilliant masses of azure blue formed by the *Lobelia* and *Wahlenbergia* flowers are visible at a considerable distance and are a beautiful sight.

*Grasses*.—No specific grass can be said to dominate this Association. The following are the most abundant and are widely dispersed throughout the whole area, for the most part grouped into small consociates:—*Aristida junciformis*, *Perotis latifolia*, *Pogonarthria falcata*, *Brachiaria serrata*, and *Eragrostis gummiflua*.

*Mosdenia transvaalensis*, a new monotypic genus allied to *Tragus*, is abundant in wooded heavy sandveld, growing in deep, loose sand.

*Hyparrhenia Ruprechtii*, which is considered to be the best thatching grass, forms considerable consociates in certain localities. Smaller consociates are frequent of *Sorghum micratherum*, *Cymbopogon excavatus*, *Hyparrhenia filipendula*, *Monocymbium ceresiaeforme*, *Digitaria eriantha*, *Tristachya pedicellata*, *Eragrostis curruia* and *E. superba*.

Common, but more scattered, grasses are: *Elionurus argenteus*, *Schizachyrium semiberbe*, *Brachiaria brizantha*, *Tricholaena rosea*, *Setaria pennis*, *Aristida congesta*, *A. sieberiana*, *A. stipodes*, *A. aequiglumis* and *A. uniplumis*, *Schmidtia bulbosa* and *Triraphis Rehmanni*.

The best pasture grasses are: *Brachiaria brizantha*, a very palatable and first class hay grass, which though stunted under ordinary Sandveld conditions, grows luxuriantly in moist places and under cultivation, and yields a large quantity of good fodder; *Brachiaria serrata*, *Eragrostis superba*, *Digitaria eriantha* and *Tricholaena rosea*.

*Ruderal grasses* are: *Cynodon Dactylon* (Kweck) which though a valuable pasture grass, runs riot in the light, sandy soil of cultivated lands and is very difficult to eradicate, owing to the vitality of its numerous deep-seated stolons, a single node of which left in the ground being sufficient to start a new plant, *Tricholaena rosea*, *Perotis latifolia*, *Tragus racemosus*, *Setaria verticillata*, *Aristida scabrivalvis*, *Eragrostis major* and *E. aspera*.

*Ruderal weeds*.—These are practically the same as in the basaltic loam association, with the addition of the following:—*Hibiscus Cannabinus*, which produces a valuable fibre and might form the basis of a large industry, is at present an abundant weed in old lands; *Oxygonum canescens* and *O. atriplicifolium*, var. *sinuatum*, *Limeum fenestratum* and *L. viscosum*, *Giesekia pharnaceoides*, *Crotalaria laburnifolia* and *C. nubica*, *Tribulus terrestris*, *Corchorus serraefolia*, *Sesamum capense*, *Ceratotheca triloba* and *Petrea zanguibarica*.

#### IV. THE ROOIBOS ASSOCIATION.

The vegetation comprising the "Rooibos" Association grows in a light sandy soil, derived on the Flats principally from the Bushveld Sandstone and distinguished from that of the Sandveld proper by being reddish and not grey in colour.

It approaches the richer areas of the Sandveld in character but is fairly distinct. It is generally known as being of a zuurveld type and goes by farmers under the name of "Rooibos" veld, which name I have retained.

It occupies small areas on the Flats between the Sandveld and Basaltic Loam soils. Along the western border, on the lower slopes of the mountains and at their base, it occupies a considerable stretch of country in felsite and oudklip soils.

It is at once recognised by the abundance of *Combretum apiculatum* (Rooibos) which is almost entirely confined to it, though occasionally found in the richer Sandveld areas into which the Rooibos Association gradually merges without any marked dividing line.

The trees are for the most part scattered, but are also found collected into clumps as in the Basaltic Loam Association. The following typical examples are taken from actual survey:—

Bush clump (a) area 8 by 11 yards:—*Rhamnus Zeyheri*, *Gymnosporia buxifolia*, *Vitex* sp. (Galpin No. M. 282), *Peltophorum africanum*, *Rhus Gueinzii*, *Carissa arduina*, *Rhoicissus cuneifolia*, *Cissus lanigera*, *Asparagus africanus*, *Cymbopogon excavatus* and *Aristida congesta*.

Bush clump (b) area 10 by 11 yards.—*Acacia caffra*, *Acacia karroo*, *Salacia? transvaalensis*, *Rhus Gueinzii*, *Carissa arduina*, *Abutilon sonneratianum*, *Pupalia lappacea*, *Asparagus africanus*, *Commelina krebsiana*, *Thunbergia atriplicifolia*.

The dominant trees are: *Combretum apiculatum* (Rooibos) already referred to, *Acacia Gerrardi* (Aapkop), which shows a preference for this Association and is mostly local in others, *Acacia caffra* (Kafir wachteenbietje) and *Peltophorum africanum* (Kajatenhout), all of which are particularly abundant. The *Peltophorum* trees as a rule are stunted and not nearly so luxuriant as the less frequent specimens found in the richer Sandveld areas.

*Pappea fulva* (Lobengula's Indaba tree), *Rhamnus Zeyheri* (Red Ivory) and *Heeria paniculosa* (Rapuis) though nowhere abundant, show a preference for this Association.

*Acacia karroo* (Sweet Thorn), *Sclerocarya caffra* (Morula), *Dombeya rotundifolia* (Drolpeer) and *Combretum Zeyheri* (Raasbos) are frequent; *Spirostachys africanus* (Thomboti), *Rhus Gueinzii* (Bastard Karree) and *R. pyroides*, *Zizyphus mucronata* (Blinkblaar wachteenbietje), *Combretum Gueinzii*, and *vitex* sp. (Galpin, No. M. 282) are occasional, whilst *Acacia robusta* (Oudoorn), *Acacia litakunensis* (Haakensteek), *Dichrostachys nutans* (Sikkelbos), *Salacia? transvaalensis* (Lepelhout), *Gymnosporia buxifolia*, *Scolopia Mundtii*, *Combretum rhodesiacum*, and *Euclea lanceolata* are rare.

*Shrubs and Herbs*.—The following are typical of the Association; *Crotalaria globifera*, *Vigna Burchellii* and *V. triloba*, *Cissus oleracea*, *Arthrosolen sericocephalus*, *Lasiosiphon Burchellii*, *Trichodesma angustifolium* and *T. physaloides*, *Bouchea hederacea*, *Clerodendron triphyllum*, *Becium obovatum* and *Vernonia monocephala*.

Other common plants are: *Commelina krebsiana*, *Eriospermum Burchellii*, *Scilla* spp., *Asparagus africanus*, *Hypoxis costata*, *Pupalia lappacea*, *Talinum caffrum*, *Elephantorrhiza Burchellii*, *Indigofera sordida*, *Tephrosia lurida*, *Rhynchosia* sp., (Galpin, M. 94), *Polygala hottentota*, *Jatropha Zeyheri*, *Zizyphus zeyheriana*, *Rhoicissus cuneifolia*, *Cissus lanigera*, *Grewia* n.sp., (Galpin M. 39), *Grewia monticola*, *Abutilon sonneratianum*, *Hermannia Woodii*, *Bergia decumbens*, *Menodora africana*, *Carissa arduina*, *Merremia palmata*, *Ipomoea crassipes*, *Lantana salvifolia*, *Striga elegans*, *S. lutea*, and *S. Thunbergii*, *Thunbergia atriplicifolia*, *Ruellia ovata*, *Crabbea hirsuta*, *Trochomeria*, sp., *Vernonia Kraussii* and *Dicoma macrocephala*.



Typical Roodbos Veld, with *Combretum apiculatum* and small trees of *Acacia caffra*. The grasses *Themeda triandra* and *Elaeagnus argentea* in the foreground on farm Arrammore (Groot Valley, No. 1545.)

Photo by E. E. Gilpin, 2 6 25.



Rooibos Veld, with *Combretum apiculatum* and a young tree of *Acacia Gerrardii* on the right. Farm Klippuit.  
Photo by E. E. Galpin, 15/6/25.





Thomboti Association on Zytorkaud. The large trees are all Thombotis. The small ones in the foreground from left to right are: *Tarchonanthus camphoratus*, *Acacia litakauensis*, *Euclea lauroleuca* and *Rhus pyroides*. The grass is *Tristachya pedicellata* (winter aspect).

Photo by E. A. Galpin, June, 1926.



Thomboti Association on Zeyelkraal. The large trees are all Thombotis. Others in the group are : *Euclea lanceolata*, *Zizyphus mucronata*, *Acacia ladangensis* and *A. petersii*, *Rhus pygmaea* and *Olea caracosa*. The grass is *Tristachya polystachya*.

Photo by E. A. Galpin, June, 1926.

*Grasses*.—The dominant grass is *Themeda triandra* (Rooigras), with *Aristida junciformis* and *Elionurus argenteus* (Lemon-scented grass) as sub-dominant.

Other common grasses are : *Schizachyrium semiberbe*, *Andropogon amplexans*, *Cymbopogon excavatus*, *Hyparrhenia filipendula*, *Heteropogon contortus*, *Brachiaria serrata*, *Panicum* n.sp., (Galpin, No. M.615), *Digitaria eriantha*, *Tricholacna rosea*, *Aristida congesta*, *A. angustata*, and *A. sieberiana*, *Crossotropis grandiglumis*, *Triraphis Rehmanni*, *Pogonarthria falcata*, *Eragrostis superba*, *E. chloromelas* and *E. lehmanniana*.

*Mosdenia waterbergensis* and *Brachiaria brizantha* are rare.

*Ruderal Plants*.—*Vigna triloba* is a common weed in lands, otherwise the ruderal plants are much the same as those of the Sandveld.

Rooibos veld affords fair grazing and is useful as a change for stock. The soil is poor in plant foods, but is of a good mechanical texture and when suitable fertilisers are applied yields excellent crops.

## V. THE THOMBOTI ASSOCIATION.

This is a small but very distinct Association bordering the eastern margin of the Nyl Vlei in the neighbourhood of Naboomspruit, extending from the farm Nyl's Vlei to the farm Vlakkpan, about sixteen miles long and from about half-a-mile to a mile in width, and is practically level. The soil is somewhat brak and consists of fine sand mixed with a small quantity of yellow clay. In seasons of heavy rainfall it is liable to inundation during February and March for several weeks at a time.

The general aspect is that of a succession of small, open, oblong, grassy, glades, surrounded by dense masses of bush, dominated by very old and large Thomboti trees (*Spirostachys africanus*) that form a conspicuous feature in the landscape. Owing to this, the locality is spoken of by natives and others as "The Thomboties."

These bush masses are raised a foot or more above the enclosed glades, probably by the action of termites. They form long belts of thick bush and trees enclosing grassy glades, 200 to 300 yards long by about 50 yards wide, with smaller, rounded or oval, bush clumps around the outer margins of the Association. The latter are usually from 15 to 20 yards in diameter and often form rings, with open centres.

The glades succeed one another in bewildering confusion for miles at a stretch and look very much alike, so that it is very easy to lose one's way in them. By the encirclement of trees, the view is restricted to the particular glade you happen to be in, leaving no guide as to direction, excepting the sun overhead, which fortunately is seldom obscured.

The great age of the trees point to this Association as being one of the chief sources from which aborescent vegetation has spread on to the basaltic loam soils on the Flats.

The dominant trees are *Spirostachys africanus* (Thomboti), *Acacia retinens* (Galpin, No. M.114—Zwaarthaak), *Acacia detinens* (Wijnruit), *Euclea lanceolata* (Guarri) and *Boscia rehmanniana* (Witgat).

*Salacia ? transvaalensis* (Lepelhou), a valuable timber tree resembling an *Elaeodendron*, which has only recently been described and provisionally placed under *Salacia* by Dr. Burt-Davy, is frequent and notable as being the biggest tree in this Association—one veteran specimen has an old and gnarled trunk 12½ feet in circumference at breast height and is 50 feet high, whilst another in full vigour is 65 feet high.

*Acacia litakunensis* (Haakensteek), *A. Benthami* (Lekkerruikpeul) and *A. hebeclada* are frequent ; *A. Burkei* (Knoppiesdoorn), *A. caffra* (Kafir

Wachteenbietje) and *A. robusta* (Oudoorn) are rare; whilst *A. Gerrardi* (Aapkop) and *A. Karroo* (Sweet Thorn) are either entirely absent or very rare.

*Combretum rhodesiacum* (Steelboom) is occasional; *C. erythrophyllum* (Vaderlands Wilgeboom) is rare; whilst *C. Zeyheri*, *C. Gueinzii* and *C. apiculatum* appear to be entirely absent.

*Rhus pyroides* (Taaibos) is abundant, *R. lancea* (Karree) occasional, whilst *Rhus Engleri* so abundant in the basaltic loam, and *R. Gueinzii*, common in the Sandveld, appear to be absent.

Other trees are: *Zizyphus mucronata* (Blinkblaar Wachteenbietje), frequent; *Peltophorum africanum* (Kajatenhout) and *Scolopia Mundtii* (Red Pear) occasional; and *Gymnosporia senegalensis*? (Galpin, No. M.56) rare.

*Shrubs*.—*Royena pallens* and *Carissa arduina* are frequent; *Rhoicissus cuneifolia*, *Ehretia hottentotica*, *Gymnosporia* sp. (Galpin, No. M.55) and *Senecio pleistoccephalus*, occasional; *Cudaba juncea*, *Jasminum breviflorum* and *Pavetta assimilis* rare.

*Shrublets and Herbs*.—The following are abundant and grow massed together in separate, dense consocieties, under shelter of the trees:—*Aloe transvaalensis*, *Sansevieria zeylanica*, *S. thyrsiflora*, *Mesembryanthemum* spp. (Galpin, Nos. M.148 and 149), *Kalanchoe glandulosa*, var. *tomentosa*, *K. rotundifolia*, *Crassula* spp. (Galpin, Nos. M.119 and 120), and *Plectranthus* spp. (Galpin, Nos. M.287 and 288.).

*Tulbaghia leucantha* appears in immense numbers in moist glades after rains in associates with the somewhat less abundant *Hypericum Lalandii*. *Wahlenbergia arenaria* and *Lobelia decipiens* form separate large consocieties under similar conditions in other glades and colour them respectively mauve and azure blue with their masses of flowers. Consocieties of *Marsilia quadrifoliata* are frequent in small hollows in the bush after they have been flooded by rains.

In a piece of open brak ground bordering the Nyl Vlei, in associates with *Acarica detinens*, the curious *Ipomoea adenioides* is abundant but very local.

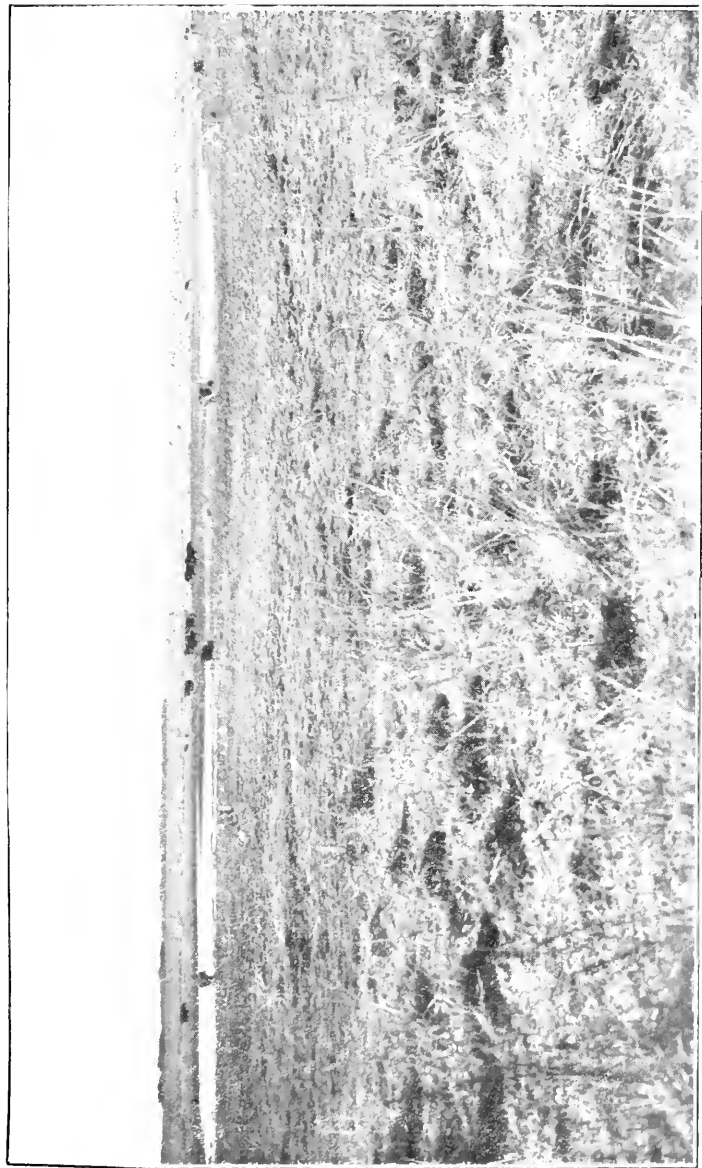
The following is a list of other species noted:—

Frequent:—*Crinum longifolium*, *Microtea tenuissime*, *Ocimum americanum*, *Lycium tenue*, *Ruellia ovata*, *Barleria jasminiflora*, *Justicia flava*.

Occasional:—*Asparagus Burkei*, *Haemanthus Katherinae*, *Hemibastardia elegans*, *Achyranthes aspera*, *Kalanchoe* sp. near *K. pyramidalis* (Galpin, No. M.620), *Pavonia macrocephala*, *Hibiscus calycinus*, *Ipomoea simplex*, *Pterodiscus speciosus*, *Barleria Mackenii*, *Blepharis molluginifolia*, *Helichrysum subglomeratum*, *Pentzia* sp. (Galpin, No. M.192), *Senecio fulgens*, *S. radicans*.

Rare:—*Asparagus africanus*, *Caralluma lutea*, *Duvalia transvaalensis*.

*Grasses*.—The dominant grass is *Tristachya pedicellata*, the majority of the glades being occupied by whole fields of it. In marshy places, *Setaria aurea* and *Eragrostis Galpinii* are abundant in small consocieties. Along the margins of the bush on the Vlei side, *Brachiaria brizantha* and *Panicum laevis* are locally abundant. Under the trees, in wooded parts, scattered plants of *Eragrostis obtusa* are everywhere prevalent. Enlacing in and amongst stunted shrubs in the smaller and drier bush clumps, *Panicum densum* is frequent, whilst on the bare, dry, raised ground surrounding them, one or other of the more brak grasses, *Sporobolus Smutsii*, *Eragrostis Atherstonei*, and *Dactyloctenium aegyptiacum*, always closely eaten down by stock, usually form small consocieties. In the larger and more open spaces surrounding the smaller bush clumps, *Themeda triandra*, *Alloteropsis semialata*, *Digitaria ciliaris*, *D. monodactyla*, and *D. Brazzae* are frequent, in addition



The Nyl Vlei on Zeyferkraal. Winter aspect : heavily grazed down.

*Photo by E. A. Galpin, June, 1926.*



The Nyl Vlei on Zyferkraal Summer aspect.

*Photo by D. F. Gilfillan.*

to the dominant *Tristachya pedicellata*. In the open, more sandy places neighbouring the bush clumps along the border furthest away from the Nyl Vlei, *Aristida junciformis* and *Eragrostis gummiflua* are dominant, *Sorghum micratherum* frequent, and *Aristida congesta*, *Pogonarthria falcata* and *Eragrostis pallens* occasional.

The bush and glades afford warmth and shelter in winter and excellent grazing. *Brachiaria brizantha*, *Panicum laevifolium* and *P. deustum* are amongst the most palatable and fattening grasses we have. The brak grasses *Sporobolus Smutsii*, *Eragrostis Atherstonei* and *Dactyloctenium aegyptiacum* are very wholesome and always eagerly sought after by stock, as is also the sweet, soft grass, *Eragrostis obtusa*. A number of other grasses are also very good and livestock quickly put on flesh on this Association and keep in good condition all the year round on the grazing.

It will be seen that the raised floors of the bush clumps bring into strange juxtaposition desert plants, such as *Boscia Rehmanniana*, *Cadaba juncea*, *Caralluma lutea*, *Pentzia* sp. and *Senecio radicans*, with moisture loving ones, like *Marsilia quadrifolia*, *Tulbaghia leucantha*, *Crinum longifolium* and *Setaria aurea*.

There are no ruderal plants, beyond a few specimens of *Opuntia Tuna* (Prickly Pear), which have not increased during the last ten years. This is probably due to the absence of homesteads and cultivation.

## VI. THE VLEI ASSOCIATION.

With the exception of a few isolated and very small patches here and there, the Vlei Association is confined to the bed and margins of the Nyl river and its tributaries, which throughout their entire course over the Flats spread out into a grassy vlei, in most places one to two miles in width, with a sluggish river channel meandering through it, which for the greater distance is broad, ill-defined, shallow and overgrown with vegetation, which completely hides the water in it, even when the latter is three or four feet deep.

Excepting in years of low rainfall, the floodwaters overflow this shallow channel during February and March and cover the greater portion of the vlei area to a depth varying from a few inches to a foot or more.

The ordinary flow of the river and its tributaries disappears underground on reaching the Flats, and, excepting in a few places and certain holes and pans, the river channels dry up a few months after cessation of the summer rains and the whole area becomes dry.

The soil consists of a dark alluvial loam of excellent mechanical texture and great fertility, which owing to underground channels and being underlain by sand is in most places unexpectedly well drained.

In places raised above the ordinary flood level, and in others where low banks have been constructed in a similar way to the "polders" in Holland to keep out flood waters from the cultivated area, exceptionally heavy yields of maize and other summer crops have been obtained.

Wheat and other winter crops can also be grown in the moisture-laden soil after the water has receded from the flooded area in the same manner as is practised in farming by the Zaaïdam method in the Western Districts of the Cape Province.

The Association is treeless and is essentially a grass one, sedges taking a subordinate place. There are islands in it here and there, studded with trees, but these are outliers of the adjacent Thomboti Association and are mostly brak.

After seasons of unusual rainfall, such as the summer of 1917-18, there is an increase in the proportion of sedges and a corresponding diminution

in that of grasses, due to the ground remaining wet throughout the dry season, but such increase has not led to anything approaching even temporary dominance, and with the return of normal years the increased hold gained by sedges has been lost and the proportions return to the normal ratio. In the same way after a series of exceptionally dry years, such as those of 1910-13, sedges were only found along the edges of the more permanent water holes. There is thus a continual oscillation in the ratio of the one to the other.

*Grasses*.—*Oryza sativa*, the rice plant, is the dominant grass in swampy localities, where it forms dense consocieties. There is no record of its occurring elsewhere in the Union in a wild state and it is difficult to know whether it is indigenous to the Nyl Vlei or has established itself in it, either from commercial rice grains dropped on the wayside or from some attempt at its cultivation in the unknown past. If the latter, it has deteriorated very much. Although attaining a height of from 5 to 8 feet when growing in water, the grain is too poor to be worth harvesting. In any case it is now thoroughly established over a considerable area.

*Phragmites communis*, the common reed, another swamp grass, is locally abundant in certain localities.

In moist, but not swampy, ground *Panicum laevifolium* one of the best hay grasses I know and usually about 6 feet high in the Vlei, is dominant and covers large areas in consocieties. *Brachiaria nigropedata*, also a first class fodder plant, is next in abundance and widely dispersed. *Eragrostis curvula*, *E. Galpinii*, *E. Lappula*, *Eulalia geniculata*, *Amphilophis insculpta* and *Setaria* sp. (Galpin, No. M.760) are frequent in small consocieties. *Paspalum scrobiculatum*, *Brachiaria brizantha*, *Setaria aurea*, *Leersia hexandra*, and *Chloris gayana* (Rhodes grass) are occasional.

In dryer localities, *Themeda triandra* (Rooigras) is practically the only grass and grows to the unusual height of four and five feet over considerable areas.

*Dactyloctenium aegyptiacum* forms a thick carpet of grass in the few patches of brak ground occasionally met with, possibly outliers of the Thomboti Association.

*Sedges*.—The dominant sedge is *Fuirena pubescens*. In many places it is the only sedge found over large portions of the periodically inundated area, in which it grows abundantly in associations with various grasses. *Kyllinga erecta* is locally abundant over smaller areas, whilst *Kyllinga alba* and other sedges not determined are frequent.

Growing along the margins of the river channel and pans *Cyperus sexangularis*, *C. esculentus* and *Mariscus rehmannianus* are frequent.

*Other Plants*.—Growing completely submerged below the surface of the water in the river channel and pan :

*Chara vulgaris* and *Potamogeton* sp. are abundant.

Having leaves floating on the surface of the water :—

*Nymphaea capensis*, very abundant ; *Aponogeton angustifolium*, locally frequent ; *Limnanthemum thunbergianum*, rare.

Growing in deep water :—

*Jussieua fluitans*, *Polygonum lapathifolium*, var. *maculatum* and *Polygonum tomentosum* are all abundant and in many places greatly impede a passage through the water.



Growing at the edge of streams and in shallow water along their margins :—

*Typha capensis* (Bullrush), *Nesaea floribunda*, *Mimulus gracilis*, *Ornithogalum zeyheri*, *Ornithogalum*, sp. (Galpin No. M. 367) are in various places locally abundant, whilst *Utricularia exoleta* and *Diclis petiolaris* are locally frequent.

In sub-swampy areas :—

*Tulbaghia leucantha*, *Hydrocotyle asiatica*, *Chironia humilis*, *Denekia capensis*, and *Epaltes gariiepina* are abundant; *Hypericum Lalandii*, *Ranunculus pinnatus*, *Amphidoxa gnaphaloides*, *Senecio Serra*, *Senecio* sp., near *S. latifolius* (Galpin No. M. 195) and *Berkheya Radula* are frequent, and *Homeria pallida* very local. The last named is the well-known poisonous "tulp." It is only found in a few spots, in small quantity, and with the abundance of good fodder plants all around, is not touched by stock.

In drier areas :—

*Scilla rigidifolia*, *Oldenlandia* sp. (Galpin No. M. 487), *Wahlenbergia arenaria* and *Lobelia decipiens* are locally abundant in restricted areas; *Crinum longifolium* and *Oldenlandia caffra* are frequent and more widely spread; *Dipcadi elatum*, *Polygonum aviculare*, *Anthospermum decumbens* and *Platycarpha* sp. (Galpin No. M. 534) are occasional.

## SYSTEMATIC CONSTITUENTS OF THE FLORA.

The following statistics are based on the list (given in the next chapter) of the Flora of the Springbok Flats so far as known. The latter has been compiled chiefly from my more intensive collections on the central portion of the Flats and will be considerably extended when the other portions come to be more fully explored. However, the central portion, which has been fairly well worked, is the most diversified of any and contains considerable areas of each of the different plant associations represented on the Flats and may be taken as typical of the whole. The chief result fuller exploration may be expected to yield will be an increase in the proportion of species to genera. The comparative position of the principal families represented is not likely to be materially altered.

The area under survey is a comparatively small one and not much can be gained by comparison of its constituents with those of the much larger floral regions into which South Africa has been divided, whilst particulars of others of similar size are not available. The chief characteristic which impresses one is the very great preponderance of *Gramineae*, the species of which form no less than 17·6 per cent. of the Flora, as compared with 8·3 per cent. in Bolus' Kalahari Region, which contains a higher percentage of *Gramineae* than any of his other five regions. As was to be expected from the proximity to the tropics, *Leguminosae* takes a very high place and comes next with 10·9 per cent. *Compositae*, which takes the first place in all of the six regions that Bolus has analysed, is surprisingly low and the species only number 4·8 per cent.

PHANEROGAMIA (Excluding 25 genera and 60 species non-native).

			Families.	Genera.	Species.
Gymnosperms	..	..	Nil.	Nil.	Nil.
Monocotyledons	..	..	12	84	181
Dicotyledons	..	..	72	119	403
			—	—	—
			84	203	584

Proportion of Monocotyledons to Dicotyledons, 1 : 2·2.

Proportion of genera to species, 1 : 2·8.

## Predominant Families.

			Number of species.	Per cent. of the whole.
Gramineae	..	..	103	17·6
Leguminosae	..	..	64	10·9
Liliaceae	..	..	40	6·8
Compositae	..	..	28	4·8
Convolvulaceae	..	..	19	3·2
Acanthaceae	..	..	18	3·0
Aclepiadaceae	..	..	17	2·9
Cucurbitaceae	..	..	16	2·7
Euphorbiaceae	..	..	15	2·5
Scrophulariaceae	..	..	14	2·4
Rubiaceae	..	..	14	2·4
Cyperaceae	..	..	13	2·2

## Predominant Families—(continued).

				<i>Number of species.</i>	<i>Per cent. of the whole.</i>
Amarantaceae	..	..	..	10	1·7
Malvaceae	..	..	..	10	1·7
Labiatae	..	..	..	10	1·7
Sapindaceae	..	..	..	9	1·5
Verbenaceae	..	..	..	9	1·5
Tiliaceae	..	..	..	8	1·3
Combretaceae	..	..	..	7	1·1
Amaryllidaceae	..	..	..	6	1·0
Iridaceae	..	..	..	6	1·0
Orchidaceae	..	..	..	6	1·0
Capparidaceae	..	..	..	6	1·0
Crassulaceae	..	..	..	6	1·0
Sterculiaceae	..	..	..	6	1·0
Boraginaceae	..	..	..	6	1·0

The following are the remaining Families arranged according to the number of species of each :—

Phytolaccaceae, Aizoaceae, Polygalaceae, Campanulaceae (5 each) ; Polygonaceae, Moraceae, Vitaceae, Ebenaceae (4 each ; Commelinaceae, Portulacaceae, Ranunculaceae, Geraniaceae, Celastraceae, Rhamnaceae, Oleaceae, Gentianaceae, Solanaceae, Pedaliaceae (3 each) ; Proteaceae, Loranthaceae, Santalaceae, Caryophyllaceae, Hippocrateaceae, Passifloraceae, Thymeliaceae, Lythraceae, Araliaceae, Umbelliferae, Sapotaceae, Loganiaceae, Selaginaceae (2 each) ; Typhaceae, Potamogetonaceae, Aponogetonaceae, Rafflesiaceae, Olacaceae, Nyctaginaceae, Nymphaeaceae, Menispermaceae, Saxifragaceae, Rosaceae, Malphigiaceae, Dichapetalaceae, Sapindaceae, Ochnaceae, Guttiferae, Elatinaceae, Violaceae, Onagraceae, Plumbaginaceae, Apocynaceae, Lentibulariaceae, Dipsacaceae (1 each).

The following are the largest genera :—

Eragrostis (19 species) ; Acacia, Ipomoea (16 each) ; Aristida, Asparagus, Tephrosia, Rhynchosia (8 each) ; Panicum, Indigofera, Senecio (7 each) ; Setaria, Scilla, Euphorbia, Combretum, Oldenlandia (6 each) ; Digitaria, Ceropegia, Striga and Cucumis (5 each).

# LIST OF THE PHANEROGAMIC PLANTS FOUND ON THE SPRINGBOK FLATS, IN THE DIVISIONS OF WATERBERG AND POTGIETERSRUST.

## EXPLANATION OF ABBREVIATIONS.

### *Plant Associations.*

T	=	The Black-Turf Association.
L	=	The Basaltic Loam Association.
S	=	The Sandveld Association.
R	=	The Rooibos Association.
Th.	=	The Thomboti Association.
V.	=	The Vlei Association.
Rud.	=	Ruderal.

### *Symbols of Frequency.*

d.	=	dominant.
s.d.	=	sub-dominant.
l.d.	=	locally dominant.
l.s.d.	=	locally sub-dominant.
a.	=	abundant.
l.a.	=	locally abundant.
f.	=	frequent.
l.	=	local.
o.	=	occasional.
r.	=	rare.
v.r.	=	very rare.

The above symbols are used together, as for example : r.T., a.L. signifies rare in the Black Turf Association and abundant in that of the Basaltic Loam.

Excepting where expressly stated, the numbers in the margin are those of my Herbarium Register, the letter M prefixing the majority indicating that the number is that of my Special Mosdene Register.

## ANGIOSPERMAE.

### MONOCOTYLEDONES.

#### TYPHACEAE.

##### **Typha, L.**

M. 373	..	..	I. <i>capensis</i> , Rohrb.	..	..	o.V.
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#### POTAMOGETONACEAE.

##### **Potamogeton, L.**

M. 762	..	..	I. sp.	..	..	a.V.
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#### APONOGETONACEAE.

##### **Aponogeton, Thb.**

M. 374	..	..	I. <i>angustifolium</i> , Ait.	..	..	l.a.V.
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#### GRAMINACEAE.

##### **Eulalia, Kunth.**

M. 442	..	..	I. <i>geniculata</i> , Stapf	..	..	l.a.V.
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##### **Ischaemum, Linn.**

M. 518, 556	..	..	I. <i>glaucoctachyum</i> , Stapf	..	..	l.a.T.
B. Davy 1138.						

##### **Sehima, Forsk.**

M. 557	..	..	I. <i>Galpinii</i> , Stent	..	..	l.d.T.
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##### **Elionurus, Humb. & Bonpl.**

M. 140	..	..	I. <i>argenteus</i> , Nees	..	..	f.R., o.S.
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<b>Sorghum, Pers.</b>			
B. Davy 1128 ..	1. <i>halepense</i> , Nees.		
M. 413 .. ..	2. <i>micratherum</i> , Stapf .. ..	l.a.S.V., f.Th.	
M. 419 .. ..	3. <i>versicolor</i> , J. N. Anders..	l.a.T.	
<b>Amphilophis, Nash.</b>			
M. 437, 562 ..	1. <i>glabra</i> , Stapf .. ..	l.T.	
M. 411 .. ..	2. <i>insculpta</i> , Stapf .. ..	l.a.T.V.	
<b>Dichanthium, Willemet.</b>			
M. 411., 560 ..	1. <i>annulatum</i> , Stapf .. ..	r.T.	
<b>Schizachyrium, Nees.</b>			
M. 414 .. ..	1. <i>semiberbe</i> , Nees .. ..	o.S.	
<b>Andropogon, Linn.</b>			
M. 616 .. ..	1. <i>amplectens</i> , Nees. .. ..	f.R.	
<b>Cymbopogon, Spreng.</b>			
M. 417 .. ..	1. <i>excavatus</i> .. ..	f.R., o.T.L.S.	
<b>Hyparrhenia Anderss.</b>			
M. 415 .. ..	1. <i>filipendula</i> , Stapf .. ..	o.L.S.R.	
M. 565 .. ..	a. <i>pilosa</i> .. ..	f.T.	
M. 418 .. ..	2. <i>Ruprechtii</i> .. ..	l.a.S.	
<b>Monocymbium, Stapf.</b>			
M. 416 .. ..	1. <i>ceresiaeforme</i> , Stapf .. ..	l.a.S.	
<b>Heteropogon, Pers.</b>			
M. 412, 564 ..	1. <i>contortus</i> , Roem. & Schult. ..	o.T.L.S.R.	
<b>Themeda, Forsk.</b>			
M. 420 .. ..	1. <i>triandra</i> , var. <i>glauca</i> , Stapf ..	d.L.R., l.s.d. T.V., o.Th.	
B. Davy 1119 ..	b. <i>hispida</i> , Stapf		
<b>Antheophora, Schreb.</b>			
M. 679 .. ..	1. <i>pubescens</i> , Nees. .. ..	l.L.	
<b>Tragus, Haller.</b>			
M. 409 .. ..	1. <i>racemosus</i> , All. .. ..	f.L., r.T.	
<b>Mosdenia, Stent.</b>			
M. 447 .. ..	1. <i>waterbergensis</i> , Stent .. ..	f.L.c., o.R.	
<b>Perotis, Ait.</b>			
M. 441 .. ..	1. <i>latifolia</i> , Ait. .. ..	f.S., o.T.	
<b>Alloteropsis, Presl.</b>			
M. 680 .. ..	1. <i>semialata</i> , Hitch., var. <i>Ecklonii</i> , Stapf .. ..	f.Th.	
<b>Paspalum, Linn.</b>			
M. 389 .. ..	1. <i>scorbiculatum</i> , L., var. <i>Commer-</i> <i>sonii</i> , Stapf .. ..	o.V.	
<b>Urochloa, Beauv.</b>			
M. 544 .. ..	1. <i>helopus</i> , Stapf .. ..	o.T.	
M. 703 .. ..	2. <i>pullulans</i> , var. <i>mossambicensis</i> , Stapf .. ..	a.T.	
M. 398 .. ..	3. <i>trichopus</i> , Stapf .. ..	f.T.L.	
M. 673 .. ..	4. n.sp. .. ..	l.a.L.	
<b>Brachiaria, Gris.</b>			
M. 399, 614 ..	1. <i>brizantha</i> , Stapf .. ..	l.a.Th., o.S.R.V.	
M. 543, 671 ..	2. <i>Isachne</i> , Stapf .. ..	l.a.T.Rud.	
M. 397, B. Davy 1109.	3. <i>nigropedata</i> , Stapf .. ..	f.L.V.	
M. 395, 613 ..	4. <i>serrata</i> , Stapf .. ..	f.L.S.	
M. 702 .. ..	5. sp... ..	f.T.	

**Echinochloa**, Beauv.

- M. 396 .. .. 1. *Holubii*, Stapf .. .. f.T., o.L.

**Panicum**, Linn.

- M. 405, 546 .. 1. *coloratum*, Lam. .. .. f.T.L.  
 M. 674 .. .. 2. *deustum*, Thunb. .. .. l.a.Th.  
 M. 401 .. .. 3. *lacrifolium*, Hack. .. .. l.d.V., o.Th., Rud.  
 M. 402, 403 .. 4. *maximum*, Jacq. .. .. l.d.L.  
 M. 545 .. .. 5. *minus*, var. *planifolium*, Stapf. .. f.T.  
 M. 548 .. .. 6. *obscurans*, Stapf .. .. o.T.  
 M. 547, 615 .. 7. n.sp. .. .. l.f.T., o.R.

**Digitaria**, Rich.

- M. 669 .. .. 1. *argyrographa*, Stapf .. .. v.l.L.  
 M. 668 .. .. 2. *Brazzae* .. .. o.Th.  
 M. 393 .. .. 3. *eriantha*, Steud. .. .. a.L.T., f.R.,  
 o.S.Th.  
 M. 393a .. .. b. *stolonifera*.  
 M. 670 .. .. 4. *monodactyla*, Stapf .. .. f.Th.  
 M. 390, 392 .. 5. *setivalva*, Stent. .. .. o.L.T.

**Tricholaena**, Schrad.

- M. 406, 542 .. 1. *rosea*, Nees. .. .. f.L., o.T.S.R.

**Xyochlaena**, Stapf.

- M. 549 .. .. 1. *monachne*, Stapf .. .. l.f.T.  
 M. 404 .. .. 2. n.sp. ? .. .. l.f.L.

**Setaria**, Beauv.

- M. 675 .. .. 1. *aurea*, A. Braun .. .. l.a.Th., o.V.  
 M. 408 .. .. 2. *Gerrardii*, Stapf .. .. o.T.  
 M. 407, 551 .. 3. *Holstii*, Herrm. .. .. d.T.  
 M. 676 .. .. 4. *imberbis*, Roem. & Schult. .. r.L.  
 M. 678 .. .. 5. *perennis*, Stapf .. .. f.S.  
 M. 436, 550 .. 6. *verticillata*, Beauv. .. .. Rud.  
 M. 760 .. .. 7. sp. .. .. a.V.

**Pennisetum**, Pers.

- M. 435, 555 .. 1. *cenchroides*, Rich. .. .. l.f.T., o.L.

**Oryza**, Linn.

- M. 444 .. .. 1. *sativa*, Linn. .. .. l.d.V.

**Leersia**, Swartz

- M. 400 .. .. 1. *hexandra*, Swartz .. .. o.V.

**Aristida**, Linn.

- M. 567 .. .. 1. *adscensionis*, L. .. .. o.T.  
 M. 713 .. .. 2. *acquiglumis*, Hack. .. .. f.S.  
 M. 422 .. .. 3. *barbicollis*, Trin. & Rupr. .. .. o.L.  
 M. 421, Davy 1112 .. 4. *congesta*, Roem. & Schult. .. f.S.R., o.L.Th.  
 M. 423, 426, 712 .. 5. *junciformis*, Trin. & Rupr. .. s.d.S., a.R., f.Th.  
 M. 427, 566 .. 6. *scabrivalvis*, Hack. .. .. Rud.  
 M. 425 .. .. 7. *sieberiana*, Trin. .. .. f.S., o.L.  
 M. 617 .. .. 8. *stipodes*, Lam., var. *meridionalis*,  
 Stapf .. .. f.S.  
 M. 424 .. .. 9. *uniplumis*, Licht. .. .. o.S.

**Sporobolus**, R.Br.

- M. 681 .. .. 1. *festicus*, var. *Stuppeus*, Stapf .. o.L.  
 Davy 1111 .. .. b. *fibrosus*, Stapf  
 M. 460 .. .. 2. *fimbriatus*, Nees, var. *latifolius*,  
 Stent .. .. r.V.  
 M. 458 .. .. 3. *pyramidalis*, Kunth. .. .. r.V.  
 M. 682 .. .. 4. *Smutsii*, Stent. .. .. l.a.Th.

**Tristachya**, Nees.

- M. 428 .. .. 1. *pedicellata*, Stent. .. .. d.Th., f.S.

<b>Cynodon, Pers.</b>					
M. 429, 568	..	1. <i>Dactylon</i> , Pers.	..	..	Rud.
<b>Chloris, Swartz.</b>					
M. 715	..	1. <i>gayana</i> , Kunth.	..	..	o.V.
M. 431	..	2. <i>petraea</i> , Thunb.	..	..	o.L.
M. 430	..	3. <i>virgata</i> , Sw.	..	..	Rud.
<b>Dinebra, Jacq.</b>					
M. 526	..	1. <i>arabica</i> , Jacq.	..	..	Rud.
<b>Eleusine, Gaertn.</b>					
M. 433	..	1. <i>indica</i> , Gaertn.	..	..	la. Rud.
<b>Dactyloctenium, Willd.</b>					
M. 432	..	1. <i>aegyptiacum</i> , Willd.	..	..	la.V. o.Th.L.
<b>Crossotropis, Stapf.</b>					
M. 434	..	1. <i>grandiglumis</i> , Rendle	..	..	f.R., o.L.
<b>Enneapogon, Desv.</b>					
M. 574, 683	..	1. <i>brachystachyus</i> , Stapf	..	..	f.T.
M. 554	..	2. <i>scoparius</i> , Stapf	..	..	f.T.L.
<b>Schmidtia, Steud.</b>					
M. 448	..	1. <i>bulbosa</i> , Stapf	..	..	f.S., o.L.
<b>Triraphis, R.Br.</b>					
M. 438	..	1. <i>Rehmanni</i> , Hack.	..	..	f.S., o.R.
M. 439	..	2. <i>Schlechterii</i> , Pilg.	..	..	r.S.
<b>Fingerhuthia, Nees.</b>					
M. 569	..	1. <i>africana</i> , Lehm.	..	..	f.T.
<b>Phragmites, Trin.</b>					
M. 720	..	1. <i>communis</i> , Trin.	..	..	o.V.
<b>Pogonarthria, Stapf.</b>					
M. 449	..	1. <i>falcata</i> , Rendle	..	..	la.S., o.L.Th.
<b>Diplachne, Beauv.</b>					
M. 540	..	1. <i>fusca</i>	..	..	r.T.
<b>Eragrostis, Beauv.</b>					
M. 440	..	1. <i>abyssinica</i> , Schrad.	..	..	r.Rud.
M. 446	..	2. <i>aspera</i> , Nees	..	..	f.Rud.
M. 443	..	3. <i>Atherstonei</i> , Stapf	..	..	a.Th., o.S.
M. 450	..	4. <i>barbinodis</i> , Hack.	..	..	o.L.
Davy 1132	..	5. <i>bicolor</i> , Nees.	..	..	..
M. 445	..	6. <i>biflora</i> , Hack.	..	..	o.L.
M. 451, 520	..	7. <i>chloromelas</i> , Steud.	..	..	ld.T.V.
M. 791	..	8. <i>curvula</i> , Nees	..	..	o.L., f.V.
M. 689	..	9. <i>denudata</i> , Hack.	..	..	o.S.
M. 456	..	10. <i>Galpinii</i> , Stent.	..	..	la.Th., o.T.V.
M. 457	..	11. <i>gummiflua</i> , Nees.	..	..	s.d.Th., f.S.
M. 685	..	12. <i>Lappula</i> , Nees	..	..	la.Th., V.
M. 455	..	13. <i>lehmanniana</i> , Nees	..	..	o.L.
M. 462	..	14. <i>major</i> , Host.	..	..	f.Rud.
M. 539	..	15. <i>namaquensis</i> , Nees	..	..	r.T.
M. 706	..	16. <i>obtusata</i> , Monro	..	..	la.Th.
M. 459, 521	..	17. <i>pallens</i> , Hack.	..	..	f.S., o.Th.
M. 538	..	18. <i>plana</i> , Nees	..	..	r.T.
M. 463	..	19. <i>superba</i> , Nees	..	..	la.L.T., o.S.R.
M. 463	..	20. sp...	..	..	o.L.
M. 452	..	21. sp...	..	..	o.L.
M. 454	..	22. sp...	..	..	o.V.

## CYPERACEAE.

<b>Kyllinga, Rottb.</b>					
M. 375	..	1. <i>alba</i> , Nees	..	..	f.V.
M. 377	..	2. <i>erecta</i> , Schum.	..	..	la.V.

**Cyperus**, Linn.

M. 387	..	..	1.	<i>esculentus</i> , Drege	..	..	o.V.
M. 380	..	..	2.	<i>marginatus</i> , Thunb.	..	..	o.S.
M. 383	..	..	3.	<i>rotundus</i> , Drege	..	..	o.T.L.
M. 385	..	..	4.	<i>sexangularis</i> , Nees	..	..	o.V.
M. 384	..	..	5.	<i>sphaerospermus</i> , Schott	..	..	l.a.S.
M. 386	..	..	6.	sp...	..	..	o.V.
M. 388	..	..	7.	sp...	..	..	o.V.

**Mariscus**, Gaertn.

M. 382	..	..	1.	<i>rehmannianus</i> , C. B. Cl.	..	..	o.V.
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**Fimbristylis**, Vahl.

M. 378	..	..	1.	<i>exilis</i> , R. & S.	..	..	o.L.
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**Bulbostylis**, Kunth.

M. 379	..	..	1.	<i>capillaris</i> , Kunth.	..	..	o.S.
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**Scirpus**, Linn.

M. 372	..	..	1.	<i>paludicola</i> , Kunth.	..	..	o.L.
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**Fuirena**, Rottb.

M. 381	..	..	1.	<i>pubescens</i> , Kunth.	..	..	d.V.
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## COMMELINACEAE, REICH.

**Commelina**, Plum.

M. 369	..	..	1.	<i>albescens</i> , Hassk.	..	..	f.L.
M. 370	..	..	2.	<i>krebsiana</i> , Kunth.	..	..	f.L., o.T.R.

**Cyanotis**, D. Don.

M. 371	..	..	1.	<i>nodiflora</i> , Kunth.	..	..	f.L.
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## LILIACEAE, HALL.

**Bulbine**, Linn.

M. 349	..	..	1.	<i>tortuosa</i> , Bkr.	..	..	o.S.
M. 770	..	..	2.	sp...	..	..	r.S.

**Anthericum**, Linn.

M. 355	..	..	1.	<i>elongatum</i> , Willd.	..	..	o.L.
M. 354	..	..	2.	<i>MacOwani</i> , Bkr.	..	..	o.L.
M. 353	..	..	3.	sp...	..	..	v.r.S.

**Chlorophytum**, Ker.

M. 357	..	..	1.	<i>elatum</i> , Bkr.	..	..	o.L.T.
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**Eriospermum**, Jacq.

M. 350. 654	..	..	1.	<i>Burchellii</i> , Bkr.	..	..	o.T.R.
M. 351	..	..	2.	sp...	..	..	r.L.
M. 352	..	..	3.	sp...	..	..	o.L.

**Aloe**, Linn.

M. 771	..	..	1.	<i>Marlothii</i> , Berger	..	..	r.S.
M. 772	..	..	2.	<i>transvaalensis</i> , Schön.	..	..	a.Th., o.L.T.
M. 773	..	..	3.	sp...	..	..	v.r.Th.

**Haworthia**, Dural.

M. 605	..	..	1.	<i>tenuifolia</i> , Engl.	..	..	r.L.
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**Tulbaghia**, Linn.

M. 358	..	..	1.	<i>leucantha</i> , Bkr.	..	..	a.V.Th.
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**Albuca**, Linn.

M. 361	..	..	1.	sp...	..	..	r.L.
M. 774	..	..	2.	sp...	..	..	r.L.

**Urginea**, Steinh.

M. 665	..	..	1.	<i>altissima</i> , Bkr.	..	..	r.S.L.
M. 775	..	..	2.	<i>Burkei</i> , Bkr.	..	..	v.r.S.L.



**Dipcadi, Medic.**

M. 359	..	..	1. <i>ciliare</i> , Bkr.	..	..	..	o.L.
M. 517	..	..	2. <i>elatum</i> , Bkr.	..	..	..	o.L.
M. 360	..	..	3. <i>rigidifolium</i> , Bkr.	..	..	..	o.L.

**Scilla, Linn.**

M. 667	..	..	1. <i>lanceaeifolia</i> , Bkr.	..	..	..	f.L.
M. 365	..	..	2. <i>rigilifolia</i> , Kunth.	..	..	..	la.V.
M. 362	..	..	3. sp...	..	..	..	f.L.
M. 363	..	..	4. sp...	..	..	..	f.L.
M. 364	..	..	5. sp...	..	..	..	o.S.
M. 666	..	..	6. sp...	..	..	..	o.S.

**Ornithogalum, Linn.**

M. 366	..	..	1. <i>Eckloni</i> , Schlecht.	..	..	..	o.L.
M. 368	..	..	2. <i>Zeyheri</i> , Bkr.	..	..	..	la.V.
M. 367	..	..	3. sp...	..	..	..	f.V.

**Sansevieria, Thunb.**

M. 334	..	..	1. <i>thyrsiflora</i> , Thb.	..	..	..	la.Th.
M. 335	..	..	2. <i>zeylanica</i> , Willd.	..	..	..	la.Th.

**Asparagus, Linn.**

M. 346	..	..	1. <i>africanus</i> , Lam.	..	..	..	o.L.R., r.Th.
M. 344	..	..	2. <i>Burkei</i> , Bkr.	..	..	..	o.T.L.S.R.Th.
M. 342	..	..	3. <i>consanguineus</i> , Bkr	..	..	..	o.L.
M. 345	..	..	4. <i>Cooperi</i> , Bkr.	..	..	..	o.L.
M. 348	..	..	5. <i>denudatus</i> , Salm Dyck	..	..	..	o.L.
M. 343	..	..	6. <i>virgatus</i> , Bkr	..	..	..	o.L.
M. 341	..	..	7. sp ..	..	..	..	o.L.
M. 347	..	..	8. sp ..	..	..	..	o.L.

**AMARYLLIDACEAE, LINDL.****Haemanthus, Linn.**

M. 338	..	..	1. <i>Katherinae</i> , Bkr...	..	..	..	o.Th.
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**Buphane, Herb.**

M. 339	..	..	1. <i>toxicaria</i> , Thunb.	..	..	..	o.L.S.
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**Crinum, Linn**

M. 337	..	..	1. <i>longifolium</i> , Thunb., var.	..	..	..	f.V.Th.
M. 653	..	..	2. sp...	..	..	..	v.I.S.

**Ammocharis, Herb.**

M. 663, 759	..	..	1. <i>falcata</i> , Herb.	..	..	..	l.f.S., v.r. T.L.
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**Hypoxis, Linn.**

M. 336	..	..	1. <i>costata</i> , Bkr.	..	..	..	f.L.R., o.S.
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**VELLOZIACEAE, DRUDE.****Barbacenia, Vand.**

M. 622	..	..	1. <i>retinervis</i> , Pax.	..	..	..	l.S.
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**DIOSCOREACEAE, Lindl.****Testudinaria, Salisb.**

M. 340	..	..	1. <i>sylvatica</i> , Kunth	..	..	..	o.L.
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**IRIDACEAE, Lindl.****Homeria, Vent.**

M. 662	..	..	1. <i>pallida</i> , Bkr.	..	..	..	o.V.
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**Babiana, Ker.**

M. 707	..	..	1. <i>Bainesii</i> , Bkr.	..	..	..	r.S.
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**Gladiolus, Linn.**

M. 333	..	..	1. <i>edulis</i> , Burch.	..	..	..	o.S.I.
M. 331	..	..	2. <i>Elliotii</i> , Bkr.	..	..	..	f.S.
M. 332	..	..	3. <i>Papilio</i> , Hook. f.	..	..	..	r.S.

**Lapeyrousia**, Pourr.

M. 330	..	..	1. <i>grandiflora</i> , Bkr.	..	..	a.L.
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## ORCHIDACEAE, Lindl.

**Habenaria**, Willd.

M. 328	..	..	1. <i>Bonatea</i> , Reichb. f.	..	..	r.L.
M. 329	..	..	2. <i>foliosa</i> , Reichb. f.	..	..	o.T.L.

**Eulophia**, R.Br.

M. 757	..	..	1. <i>aemula</i> , Schltr.	..	..	r.T.
M. 327	..	..	2. <i>robusta</i> , Rolfe	..	..	r.L.
M. 756	..	..	3. <i>sp. near E. chlorantha</i>	..	..	r.L.
M. 326	..	..	4. <i>sp.</i>	..	..	r.L.

**DICOTYLEDONEAE.**

## ARCHICHLAMYDEAE (Polypetalae and Apetalae.)

## MORACEAE, Lindl.

**Ficus**, Linn.

M. 647	..	..	1. <i>capensis</i> , Thunb.	..	..	r.S.
M. 532	..	..	2. <i>Pretoriae</i> , Burt-Davy ?	..	..	r.S.
M. 604	..	..	3. <i>Soldanella</i> , Warb.	..	..	r.S.
M. 661	..	..	4. <i>sp.</i>	..	..	r.S.

## PROTEACEAE, J. St. Hil.

**Faurea**, Harv.

M. 310	..	..	1. <i>saligna</i> , Harv.	..	..	o.S.
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**Protea**, Linn.

M. 621	..	..	1. <i>hirta</i> , Klotzsch	..	..	r.S.
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## LORANTHACEAE, D. Don.

**Loranthus**, Linn.

M. 312	..	..	1. <i>Zeyheri</i> , Harv.	..	..	o.L.
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**Viscum**, Linn.

M. 313	..	..	1. <i>rotundifolium</i> , Thunb.	..	..	o.S.
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## SANTALACEAE, R. Br.

**Thesium**, Linn.

M. 315	..	..	1. <i>gracilarioides</i> , A. W. Hill	..	..	o.L.
M. 314	..	..	2. <i>juncum</i> , Bernh.	..	..	o.S.

## RAFFLESIIACEAE.

**Hydnora**, Thunb.

M. 776	..	..	1. <i>sp.</i>	..	..	v.r.L.
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## OLACACEAE, Lindl.

**Ximenia**, Linn.

M. 10	..	..	1. <i>americana</i> , Linn.	..	..	r.S.
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## POLYGONACEAE, Lindl.

**Polygonum**, Linn.

B. Davy 2494	..	..	1. <i>aviculare</i> , Linn.			
M. 307	..	..	2. <i>lapathifolium</i> , var. <i>maculatum</i> , Dyer & Trin.	..	..	l.a.V.
M. 306	..	..	3. <i>tomentosum</i> , Willd.	..	..	l.a.V.

**Oxygonum**, Burch.

M. 309	..	..	1. <i>atriplicifolium</i> , var. <i>sinuatum</i> , Bkr.	..	..	f.S. Rud.
M. 305	..	..	2. <i>caneens</i> , Sond.	..	..	o.L.S.

## CHENOPODIACEAE, Less.

**Chenopodium**, Linn.

M. 754	..	..	1. <i>album</i> , Linn.	..	..	..	r. Rud.
M. 777	..	..	2. <i>Botrys</i> , Linn.	..	..	..	r. Rud.
M. 778	..	..	3. <i>murale</i> , Linn.	..	..	..	r. Rud.

## AMARANTACEAE, Juss.

**Hermbstaedtia**, Reichb.

M. 296	..	..	1. <i>elegans</i> , Moq.	..	..	..	f.S., o.T.Th.
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**Amarantus**, Linn.

M. 294	..	..	1. <i>paniculatus</i> , Linn.	..	..	..	la.Rud.
M. 295	..	..	2. <i>Thunbergii</i> , Moq.	..	..	..	la.Rud.

**Sericorema**, Lopr.

M. 304	..	..	1. <i>remotiflora</i> , Lopr.	..	..	..	o.L.
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**Cyphocarpa**, Lopr.

M. 297	..	..	1. <i>angustifolia</i> , Lopr.	..	..	..	o.S.
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**Cyathula**, Lour.

M. 779	..	..	1. <i>globulifera</i> , Moq.	..	..	..	o.L.
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**Pupalia**, Juss.

M. 298	..	..	1. <i>lappacea</i> , Juss.	..	..	..	o.L.R.
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**Aerva**, Forsk.

M. 299	..	..	1. <i>leucura</i> , Moq.	..	..	..	o.S.
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**Achyranthes**, Linn.

M. 301, 603	..	..	1. <i>aspera</i> , Linn.	..	..	..	o.T.Th.
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**Achyroasis**, Hook.f.

M. 300	..	..	1. <i>leptostachya</i> , Hook.f.	..	..	..	o.T.
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**Alternanthera**, Forsk.

M. 302	..	..	1. <i>Achyrantha</i> , R. Br.	..	..	..	la.Rud.
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**Gomphrena**, Linn.

M. 303	..	..	1. <i>globosa</i> , Linn.	..	..	..	la.Rud.
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## NYCTAGINACEAE, Lindl.

**Boerhaavia**, Vaill.

M. 292	..	..	1. <i>pentandra</i> , Burch.	..	..	..	o.Rud. in T.
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## PHYTOLACCACEAE, Lindl.

**Microtea**, Swartz.

M. 308	..	..	1. <i>tenuissima</i> , N.E. Br.	..	..	..	lf.S.Th.
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**Limeum**, Linn.

M. 4	..	..	1. <i>fenestratum</i> , Heimerl.	..	..	..	la.S.
M. 156	..	..	2. <i>viscosum</i> , Fenzl.	..	..	..	f.S.
M. 154	..	..	3. <i>sp.</i>	..	..	..	la.S.

**Giesekia**, Linn.

M. 155, 157	..	..	1. <i>pharnaceoides</i> , Linn.	..	..	..	f.S.
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## PORTULACACEAE, Reichb.

**Talinum**, Adans.

M. 291	..	..	1. <i>cafrum</i> , E. & Z.	..	..	..	f.L., o.R.
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**Portulaca**, Linn.

M. 780	..	..	1. <i>oleracea</i> , Linn.	..	..	..	f.Rud.
M. 15	..	..	2. <i>pilosa</i> , Linn.	..	..	..	o.S.
M. 151	..	..	3. <i>quadrifida</i> , Linn.	..	..	..	f.Rud.
M. 150	..	..	4. <i>n. sp. ?</i>	..	..	..	la.S.

## AIZOACEAE, A. Br.

**Glinus**, Loefl.

M. 153	..	..	1. <i>sp.</i> = Schltr. 11873	..	..	..	o.T.
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**Pharnaceum**, Linn.

- M. 152 .. .. 1. *verrucosum*, E. & Z. .. .. l.a.T.

**Orygia**, Forsk.

- M. 733 .. .. 1. *decumbens*, Forsk. .. .. f.T. (in asgrond).

**Mesembrianthemum**, Linn.

- M. 148 .. .. 1. sp. .. .. o.Th.  
M. 149 .. .. 2. sp. .. .. o.Th.

## CARYOPHYLLACEAE, Reichb.

**Pollichia**, Soland.

- M. 293 .. .. 1. *campestris*, Ait. .. .. o.L.

**Dianthus**, Linn.

- M. 14 .. .. 1. *crenatus*, Thunb. .. .. r.S.

## NYMPHAEACEAE, D.C.

**Nymphaea**, Linn.

- M. 466 .. .. 1. *capensis*, Thunb. .. .. l.d.V.

## RANUNCULACEAE, Juss.

**Clematis**, Linn.

- M. 1 .. .. 1. *brachiata*, Thunb. .. .. o.S.  
M. 2 .. .. 2. *Stanleyi*, Hook. .. .. l.a.S.

**Ranunculus**, Hall.

- M. 465 .. .. 1. *pinnatus*, Poir. .. .. o.V.

## MENISPERMACEAE, D.C.

**Antizoma**, Miers.

- M. 624 .. .. 1. *harveyana*, Miers .. .. v.l.L.

## CRUCIFERAE, B.Juss.

**Lepidium**, Linn.

- M. 3 .. .. 1. *capense*, Thunb. .. .. l.f.Rud.

## CAPPARIDACEAE, Lindl.

**Cleome**, Linn.

- M. 6 .. .. 1. *maculata*, Sond. .. .. f.S.  
M. 8 .. .. 2. *papillosa*, Steud. .. .. r.L.

**Gynandropsis**, D.C.

- M. 781 .. .. 1. *pentaphylla*, D.C. .. .. o.Rud.

**Polanisia**, Raf.

- M. 5 .. .. 1. sp. .. .. o.Rud.  
M. 7 .. .. 2. sp. .. .. o.Rud.

**Boscia**, Lam.

- M. 467 .. .. 1. *albitrunca*, Gilg & Benedict .. .. r.S.  
M. 9 .. .. 2. *rehmannia*, Pest. .. .. a.Th., f.L.

**Cadaba**, Forsk.

- M. 626 .. .. 1. *juncea*, Bth. & Hook. .. .. v.r.Th.

## CRASSULACEAE, D.C.

**Kalanchoe**, Adams.

- M. 123 .. .. 1. *glandulosa*, Hochst., var.  
*tomentosa*, Kensit .. .. l.a.Th.L.  
M. 122 .. .. 2. *rotundifolia*, Haw. .. .. l.a.L., o.Th.  
M. 620 .. .. 3. sp. near *K. pyramidalis* .. .. v.l.L., o.Th.

**Crassula**, Linn.

- M. 121 .. .. 1. *nodulosa*, Schön. .. .. o.S.  
M. 120 .. .. 2. n.sp. .. .. f.Th.  
M. 119 .. .. 3. sp. .. .. f.Th.

## SAXIFRAGACEAE, D.C.

**Vahlia**, Thunb.

- M. 118 .. .. 1. *capensis*, Thunb. .. .. l.a.S.

## ROSACEAE, B.Juss.

**Parinarium**, Aub.

- M. 117 .. .. 1. *capense*, Harv. .. .. l.s.d.S.

## LEGUMINOSAE, Juss.

**Acacia**, Willd.

- 137, M. 783 .. 1. *albida*, Del. .. .. v.l.V.  
 M. 109 .. 2. *Benthami*, Rochebr. .. .. l.a.T., f.Th., o.S.  
 M. 106 .. 3. *Burkei*, Benth. .. .. o.S., r.Th.  
 M. 111 .. 4. *caffra*, Willd. .. .. a.R., f.S., r.Th.  
 M. 112 .. 5. *detinens*, Burch. .. .. a.Th., r.L.  
 M. 483 .. 6. *Galpinii*, Burtt-Davy .. .. v.l.V.  
 M. 474 .. 7. *Gerrardi*, Benth. .. .. a.R., o.T.L.  
 M. 108 .. 8. *giraffae*, Burch. .. .. r.S.  
 M. 115 .. 9. *hebeclada*, D.C. .. .. o.Th., r.L.  
 M. 110 .. 10. *karroo*, Hayne .. .. sd.L., o.T.R.S.  
 8808—M. 782 .. 11. *lasiopetala*, Oliver .. .. v.l.S.  
 M. 113 .. 12. *litakunensis*, Burch. .. .. s.d.L., f.Th., o.T.  
 M. 113<sub>a</sub> .. b. var. *stolonifera* .. .. v.r.R. f.L.  
 M. 528 .. 13. *natalitia*, E.Mey., var. *stolonifera* l.d.T.  
 M. 475 .. 14. *permixta*, var. *glabra*, Burtt-Davy l.d.T.  
 M. 107 .. 15. *robusta*, Burch. .. .. f.L., r.T.R.S.Th.  
 M. 114 .. 16. *retinens*, L. .. .. s.d.Th., r.L.

**Dichrostachys**, W. & A.

- M. 116 .. .. 1. *nutans*, Benth. .. .. l.a.S., f.L., o.T., r.R.

**Elephantorrhiza**, Benth.

- M. 105 .. .. 1. *Burchellii*, Benth. .. .. f.S.T., o.L.R.

**Burkea**, Benth.

- M. 104 .. .. 1. *africana*, Hook. .. .. l.d.S.

**Schotia**, Jacq.

- M. 649 .. .. 1. *brachypetala*, Sond. .. .. l.R.

**Bauhinia**, Linn.

- M. 103 .. .. 1. *macrantha*, Oliver .. .. a.S.

**Cassia** Linn.

- M. 473 .. 1. *absus*, Linn. .. .. a.S.  
 M. 102 .. 2. *mimosoides*, Linn. .. .. f.T., o.R.S.  
 M. 101 .. 3. *obovata*, Collad. .. .. a.L.

**Pterolobium**, R. Br.

- 8972, M. 786 .. 1. *lacerans*, R. Br. .. .. l.R.

**Peltophorum**, Vog.

- M. 100 .. .. 1. *africanum* Sond. .. .. a.R., f.S., o.L.Th.  
 v.r.T.

**Bolusanthus**, Harms.

- M. 645 .. .. 1. *speciosus*, Harms .. .. v.l.L.

**Listia**, E. Mey.

- M. 70 .. .. 1. *heterophylla*, E. Mey. .. .. l.f.S.

**Crotalaria**, Linn.

- M. 536 .. 1. *globifera*, E. Mey. .. .. l.R.  
 M. 72 .. 2. *laburnifolia*, Linn. .. .. o.S.  
 M. 71 .. 3. *lotoides*, Benth. .. .. f.Rud.  
 M. 73 .. 4. *nubica*, Benth. .. .. r.Rud.  
 M. 726 .. 5. *spinosa*, var. *Schlechteri*, Bkr.f... o.T.(in asgrond).

**Indigofera, Linn.**

M. 79	..	..	1. <i>daleoides</i> , Benth.	..	..	o.S.
M. 727	..	..	2. <i>disticha</i> , E. & Z.	..	..	r.Rud.
M. 78	..	..	3. <i>filipes</i> , Benth.	..	..	o.S.
M. 76, 582	..	..	4. <i>hilaris</i> , E. & Z.	..	..	a.T.
M. 471	..	..	5. <i>oxytropis</i> , Benth.	..	..	a.S.
M. 77	..	..	6. <i>sordida</i> , Benth.	..	..	a.S., f.R.
M. 75	..	..	7. sp.	..	..	o.L.
M. 80	..	..	8. sp.	..	..	o.S.

**Tephrosia, Pers.**

M. 82	..	..	1. <i>capensis</i> , Pers.	..	..	f.L.
M. 81	..	..	2. <i>lupinifolia</i> , D.C.	..	..	o.T.
M. 87 & 628	..	..	3. <i>lurida</i> , Sond.	..	..	r.R.S.
M. 90	..	..	4. <i>plicata</i> , Oliver ?	..	..	r.S.
M. 83	..	..	5. <i>semiglabra</i> , Sond.	..	..	o.L.S.
M. 84	..	..	6. sp.	..	..	f.S.
M. 85	..	..	7. sp.	..	..	o.S.
M. 86	..	..	8. sp.	..	..	o.S.

**Mundulea, Benth.**

M. 88	..	..	1. <i>suberosa</i> , Benth.	..	..	o.S.
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**Sesbania, Pers.**

M. 527	..	..	1. <i>mossambicensis</i> , Klotzsch	..	..	a.T.
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**Stylosanthes, Linn.**

M. 409	..	..	1. <i>mucronata</i> , Willd.	..	..	r.S.
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**Zornia, Gmel.**

M. 89	..	..	1. <i>tetraphylla</i> , Michx	..	..	l.a.S.
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**Glycine, Linn.**

M. 583	..	..	1. <i>micans</i> , Welw. ?	..	..	l.f.T.
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**Erythrina, Linn.**

M. 652	..	..	1. <i>caffra</i> , Thunb.	..	..	r.S.
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**Rhynchosia, Lour.**

M. 97	..	..	1. <i>minima</i> , D.C.	..	..	r.S.
M. 98	..	..	2. <i>nitens</i> , Benth.	..	..	l.L.T.
M. 95	..	..	3. n. sp.	..	..	o.S.
M. 93 & 584	..	..	4. sp. cf. <i>R. Memnonia</i> , D.C. var. <i>prostrata</i>	..	..	f.T.
M. 94 & 585	..	..	5. sp.	..	..	f.L., o.T.R.
M. 96	..	..	6. sp.	..	..	o.S.
M. 629	..	..	7. sp.	..	..	l.S.
M. 586	..	..	8. sp.	..	..	a.T.

**Eriosema, D.C.**

M. 99	..	..	1. <i>oblongum</i> , Benth.	..	..	o.S.
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**Vigna, Savi.**

M. 694 & 728	..	..	1. <i>Burchellii</i> , Harv.	..	..	f.T. (asgrond) a.R. Also Ruderal in R..
M. 92 & 729	..	..	2. <i>triloba</i> , Walp.	..	..	a.R., o.T.
M. 91	..	..	3. <i>rexillata</i> , Benth.	..	..	o.T.

**GERANIACEAE, J. St. Hil.****Monsonia, Linn.**

M. 49	..	..	1. <i>biflora</i> , D.C.	..	..	o.Rud.
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**Pelargonium, L'Her.**

M. 50	..	..	1. <i>aconitophyllum</i> , E. & Z.	..	..	r.S.
M. 763	..	..	2. sp. near <i>P. myrrhifolium</i> , Ait.	..	..	r.S.

**OXALIDACEAE, Lindl.****Oxalis, Linn.**

M. 51	..	..	1. <i>convexula</i> , Jacq.	..	..	f.S.
M. 785	..	..	2. <i>corniculata</i> , Linn.	..	..	o.Rud.

## ZYGOPHYLLACEAE, Lindl.

**Tribulus**, Tourn.

- M. 48 .. .. 1. *terrestris*, Linn. .. .. o.Rud.

## MALPIGHIACEAE, Vent.

**Sphedamnocarpus**, Planch.

- M. 47 .. .. 1. *pruriens*, Planch. .. .. o.S.

## POLYGALACEAE, Lindl.

**Polygala**, Linn.

- M. 722 .. .. 1. *arenaria*, Willd. .. .. l.a.L.  
 M. 11 .. .. 2. *hottentota*, Presl. .. .. o.L.S.R.  
 M. 655 .. .. 3. *leptophylla*, Burch. .. .. r.S.  
 M. 12 .. .. 4. *virgata*, Thunb. .. .. r.S.

**Securidaca**, Linn.

- M. 13 .. .. 1. *longepedunculata*, Fres. .. .. f.S.

## DICHAPETALACEAE, Engl.

**Dichapetalum**, Thou.

- M. 53 .. .. 1. *cymosum*, Engl. .. .. o.S.

## EUPHORBACEAE, J. St. Hil.

**Phyllanthus**, Linn.

- M. 660 .. .. 1. *incurvus*, Thunb. .. .. r.S.  
 M. 321 & 711 .. 2. *maderaspatensis*, Linn. .. .. f.Rud.

**Acalypha**, Linn.

- M. 608 .. .. 1. *segetalis*, Müll. Arg. .. .. l.f.Rud. in T.  
 M. 322 .. .. 2. *sp.* .. .. o.S.

**Tragia**, Plum.

- M. 324 .. .. 1. *dioica*, Sond. .. .. f.L.  
 M. 589 .. .. 2. *incisifolia*, Prain .. .. l.a.T.

**Ricinus**, Linn.

- M. 784 .. .. 1. *communis*, Linn. .. .. r.Rud.

**Jatropha**, Linn.

- M. 607 .. .. 1. *Schlechteri* .. .. o.T.  
 M. 230 .. .. 2. *Zeyheri*, Sond. .. .. f.L., o.R.

**Spirostachys**, Sond.

- M. 323 .. .. 1. *africanus*, Sond. .. .. d.Th., o.L.S.R.

**Euphorbia**, Linn.

- B. Davy 2196 .. 1. *Davyi*, N.E.Br.  
 M. 319 .. .. 2. *ingens*, E. Mey .. .. v.r.S.  
 Schltr. 4278 .. 3. *neopolycnemoides*, Pax & Hoffm.  
 M. 316 .. .. 4. *sp.* .. .. f.L.  
 M. 317 .. .. 5. *sp.* .. .. f.L.  
 M. 318 .. .. 6. *pseudotuberosa*, Pax .. .. f.L.

## ANACARDIACEAE, Lindl.

**Sclerocarya**, Hochst.

- M. 67 .. .. 1. *caffra*, Sond. .. .. o.R., r.L.

**Lannea**, A. Rich.

- M. 66 .. .. 1. *discolor*, Engl. .. .. o.S.  
 M. 65 .. .. 2. *edulis*, Engl. .. .. o.S.

**Heeria**, Meisn.

- M. 637 .. .. 1. *paniculosa*, O. Ktze .. .. r.S., o.R.  
 M. 656 .. .. 2. *salicina*, Engl. .. .. v.r.S.

**Rhus**, Linn.

- M. 693 .. .. 1. *Gueinzii*, Sond. .. .. o.S.  
 M. 63 .. .. 2. *pyroides*, Burch. .. .. f.Th., o.T.L.R.  
 M. 62 & 580 .. 3. *lancea*, Linn. .. .. o.T.L.Th.  
 M. 64 & 581 .. 4. *Engleri*, Britt. .. .. f.L., o.T.

## CELASTRACEAE, Lindl.

**Gymnosporia**, Benth.

M. 54 & 578	..	1.	<i>buxifolia</i> , Szysz.	..	..	f.L., o.T., r.R.
M. 56	..	2.	<i>senegalensis</i> , Lam.	..	..	r.Th.
M. 55	..	3.	sp.	..	..	a.L. o.Th

## HIPPOCRATEACEAE, H.B. &amp; K.

**Salacia**, Linn.

M. 627	..	1.	<i>Rehmannii</i> , Schinz	..	..	r.S.
M. 468	..	2.	? <i>transvaalensis</i> , Burt-Davy	..	..	f.Th.
M. 469 & 470	..		do.	variety ?	..	o.L.S., r.R.

## SAPINDACEAE, Juss.

**Pappea**, E. & Z.

M. 61	..	1.	<i>fulva</i> , Conrath	..	..	o.R., r.L.S.
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## RHAMNACEAE.

**Zizyphus**, Linn.

M. 57 & 579	..	1.	<i>mucronata</i> , Willd	..	..	f.L.S.Th., o.T.R.
M. 484	..		(b) var. <i>pubescens</i> , Sond.	..	..	o.S.
M. 58	..	2.	<i>zeyheriana</i> , Sond.	..	..	l.a.S.R.

**Rhamnus**, Linn.

M. 648	..	1.	<i>Zeyheri</i> , Sond.	..	..	r.S., o.R.
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## AMPELIDACEAE.

**Rhoicissus**, Planch.

M. 60	..	1.	<i>cuneifolia</i> , Planch.	..	..	f.L., o.R.Th.
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**Cissus**, Linn.

M. 59	..	1.	<i>lanigera</i> , Harv.	..	..	f.L.R.
M. 623	..	2.	<i>oleracea</i> , Bohus	..	..	r.R.
M. 657	..	3.	sp.	..	..	v.r.L.

## TILIACEAE, Juss.

**Corchorus**, Linn.

M. 44	..	1.	<i>asplenifolius</i> , Burch.	..	..	o.L.T.
M. 45 & 724	..	2.	<i>serraeifolius</i> , Burch.	..	..	f.S.Rud., o.L.
M. 725	..	3.	<i>trilocularis</i> , Linn.	..	..	a.T. in asgrond.

**Grewia**, Linn.

M. 40	..	1.	<i>caffra</i> , Meisn.	..	..	a.S.
M. 41	..	2.	<i>monticola</i> , Sond.	..	..	o.R.S.
M. 39	..	3.	n.sp. ?	..	..	f.L., o.T., r.R.

**Triumfetta**, Plum.

M. 43	..	1.	<i>trichocarpa</i> , Sond.	..	..	f.S.
M. 42	..	2.	sp.	..	..	l.a.S.

## MALVACEAE, Juss.

**Abutilon**, Gaertn.

M. 23	..	1.	<i>sonneratianum</i> , Cav.	..	..	o.L.R.
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**Sida**, Linn.

M. 22	..	1.	<i>cordifolia</i> , Linn.	..	..	o.L.S.T.
M. 19	..	2.	<i>longipes</i> , E. Mey.	..	..	o.L.T.
M. 20	..	3.	<i>rhombifolia</i> , Linn.	..	..	o.L.

**Pavonia**, Linn.

M. 18	..	1.	<i>macrophylla</i> , E. Mey.	..	..	o.L.Th.
M. 31	..	2.	<i>zeylanica</i> , Cav.	..	..	o.L.

**Hibiscus**, Linn.

M. 24	..	1.	<i>calycinus</i> , Willd.	..	..	o.L.Th.
M. 32	..	2.	<i>Cannabinus</i> , Linn.	..	..	a.S. & Rud.
M. 25	..	3.	<i>physaloides</i> , Cuill. & Perr.	..	..	l.S.
M. 26	..	4.	<i>pusillus</i> , Thunb.	..	..	o.L.
M. 30	..	5.	<i>Trionum</i> , Linn.	..	..	o.Rud.



**Gossypium**, Linn.

- M. 723 .. .. 1. *herbaceum*, L. .. .. v.r. L.S.

## STERCULIACEAE.

**Melhania**, Forsk.

- M. 34 .. .. 1. *sp.* .. .. o.L.

**Dombeya**, Cav.

- M. 33 .. .. 1. *rotundifolia*, Harv. .. .. f.R.S.

**Hermannia**, Linn.

- M. 35 .. .. 1. *borraginiflora*, Hook. .. .. f.S., o.L.  
 M. 36 .. .. 2. *brachypetala*, Harv. .. .. o.L.  
 M. 37 .. .. 3. *Woodii*, Schinz .. .. o.S.R.

**Waltheria**, Linn.

- M. 38 .. .. 1. *indica*, Linn. .. .. f.S., o.T.

## OCHNACEAE, Lindl.

**Ochna**, Schreb.

- M. 52 .. .. 1. *pulchra*, Hook. .. .. f.S.

## GUTTIFERAE, Juss.

**Hypericum**, Linn.

- M. 46 .. .. 1. *Lalandii*, Chois. .. .. la.Th.

## \* ELATINACEAE, Lindl.

**Bergia**, Linn.

- M. 286 .. .. 1. *decumbens*, Planch. .. .. o.S.R.

## VIOLACEAE.

**Ionidium**, D.C.

- M. 576 .. .. 1. *enneaspermum*, Vent. .. .. f.Rud. in T.

## FLACOURTIACEAE, Dumort.

**Scolopia**, Shreb.

- M. 690 .. .. 1. *Mundtii*, Sysz., var. *Engleri*,  
 Phillips .. .. o.Th., r.R.  
 M. 691 .. .. „ (b) var. *inermis* .. .. r.S.

## PASSIFLORACEAE, Lindl.

**Ceratosicyos**, Nees.

- M. 131 .. .. 1. *Eckloni*, Nees .. .. r.L.

**Adenia**, Forsk.

- M. 142 .. .. 1. *multifida* .. .. o.L.

## THYMELAEACEAE, Reichb.

**Lasiosiphon**, Fresen.

- M. 755 .. .. 1. *Burchellii*, Meisn. .. .. l.R.

**Arthrosolen**, C.A. Mey.

- M. 311 .. .. 1. *sericeocephalus*, Meisn. .. .. o.R.

## LYTHRACEAE, Lindl.

**Lythrum**, Linn.

- M. 730 .. .. 1. *sagittaeifolium*, Sond. .. .. la.T.

**Nesaea**, Comm.

- M. 129 .. .. 1. *floribunda*, Sond. .. .. la.V.

## COMBRETACEAE, R. Br.

**Combretum**, Linn.

- M. 126 .. .. 1. *apiculatum*, Sond. .. .. a.R., v.r.S.  
 M. 642 & 650 .. .. 2. *erythrophyllum*, Sond. .. .. r.V., v.r.Th.  
 M. 127 .. .. 4. *Gueinzii*, Sond. .. .. o.S.R.  
 M. 646 .. .. 3. *imberbe*, Wawra, var. *Petersii*,  
 Engl. & Diels .. .. l.S.  
 M. 125 .. .. 5. *rhodesiacum*, Bkr. f. .. .. f.L., o.Th., r.R.  
 M. 128 .. .. 6. *Zeyheri*, Sond. .. .. o.S.R.

<b>Terminalia</b> , Linn.					
M. 124	..	..	1. <i>sericea</i> , Burch.	..	.. l.d.S.
<b>ONAGRACEAE</b> , Lindl.					
<b>Jussiaea</b> , Linn.					
M. 130	..	..	1. <i>fluitans</i> , Hochst.	..	.. l.a.V.
<b>ARALIACEAE</b> , Vent.					
<b>Cussonia</b> , Thunb.					
M. 161	..	..	1. <i>natalensis</i> , Sond.	..	.. o.S.
M. 140	..	..	2. <i>spicata</i> , Thunb.	..	.. v.r.S.
<b>UMBELLIFERAE</b> , Morison.					
<b>Hydrocotyle</b> , Tourn.					
M. 158 & 695	..	..	1. <i>asiatica</i> , Linn.	..	.. l.f.V.
<b>Heteromorpha</b> , Cham. & Schlecht.					
M. 159	..	..	1. <i>arborescens</i> , Ch. & Sch.	..	.. o.L.
<b>METACHLAMYDEAE</b> (Sympetaleae).					
<b>PLUMBAGINACEAE</b> , Lindl.					
<b>Plumbago</b> , Linn.					
M. 203	..	..	1. <i>capensis</i> , Thunb.	..	.. r.S.
<b>SAPOTACEAE</b> .					
<b>Chrysophyllum</b> , Linn.					
M. 639	..	..	1. <i>magalismontanum</i> , Sond.	..	.. r.S.
<b>Mimusops</b> , Linn.					
M. 638	..	..	1. <i>Zeyheri</i> , Sond.	..	.. r.S.
<b>EBENACEAE</b> , Vent.					
<b>Royena</b> , Linn.					
M. 204 & 590	..	..	1. <i>pallens</i> , Thunb.	..	.. o.L.Th.T.
<b>Euclea</b> , Murr.					
M. 205	..	..	1. <i>lanceolata</i> , E.Mey.	..	.. a.Th., f.L., r.R.
M. 644	..	..	2. <i>multiflora</i> , Hiern.	..	.. o.S.
M. 632	..	..	3. <i>sp.</i>	..	.. o.S.
<b>OLEACEAE</b> , Lindl.					
<b>Olea</b> , Linn.					
M. 208	..	..	1. <i>verrucosa</i> , Link	..	.. o.S.L.
<b>Menodora</b> , Humb. & Bonpl.					
M. 207	..	..	1. <i>africana</i> , Hook.	..	.. f.S., o.R.
<b>Jasminum</b> , Linn.					
M. 494	..	..	1. <i>breviflorum</i> , Harv.	..	.. r.Th.
<b>LOGANIACEAE</b> , Lindl.					
<b>Strychnos</b> , Linn.					
M. 220	..	..	1. <i>pungens</i> , Solered.	..	.. f.S.
M. 221	..	..	2. <i>schumanniana</i> , Gilg	..	.. f.S.
<b>GENTIANACEAE</b> , Dumort.					
<b>Exochaenium</b> , Griseb.					
M. 741	..	..	1. <i>grande</i> , Griseb.	..	.. v.r.L.
<b>Chironia</b> , Linn.					
M. 222	..	..	1. <i>humilis</i> , Gilg, var. <i>Wilmsii</i> , Prain	a.V.	
<b>Limnanthemum</b> , S. G. Gmel.					
M. 496	..	..	1. <i>thunbergianum</i> , Griseb.	..	.. r.V

## APOCYNACEAE, Lindl.

**Carissa**, Linn.

- M. 209 .. .. 1. *Arduina*, Lam. .. .. f.L.Th., r.R.

## ASCLEPIADACEAE, Lindl.

**Cryptolepis**, R. Br.

- M. 495 .. .. 1. *oblongifolia*, Schltr. .. .. o.S.

**Raphionacme**, Harv.

- M. 211 .. .. 1. *Burkei*, N.E. Br. .. .. o.L.  
M. 210 .. .. 2. *divaricata*, Harv. .. .. o.L.

**Schizoglossum**, E. Mey.

- M. 740 .. .. 1. *biflorum*, Schltr. ... .. v.r.L.

**Asclepias**, Linn.

- M. 591 .. .. 1. *Burchellii*, Schltr. .. .. r.S.  
M. 213 .. .. 2. *Crispa*, Berg., var. .. .. r.L.  
M. 212 .. .. 3. *macropus*, Schltr. .. .. r.L.

**Pachycarpus**, E. Mey.

- M. 513 .. .. 1. *schinzianus*, N.E. Br. .. .. r.T.

**Pentarrhinum**, E. Mey.

- M. 214 & 519 .. 1. *insipidum*, E. Mey. .. .. o.S., r.T.

**Ceropegia**, Linn.

- M. 698 .. .. 1. *pachystelma*, Schltr. .. .. v.r.L.  
M. 215 .. .. 2. n.sp. = Gov. Herb. No. 10179 .. .. v.r.L.  
M. 216 .. .. 3. sp. .. .. v.r.L.  
M. 217 .. .. 4. sp. .. .. v.r.L.  
M. 697 .. .. 5. sp. .. .. v.r.L.

**Brachystelma**, R. Br.

- M. 658 .. .. 1. *Barberiae*, Harv. .. .. v.r.L.

**Caralluma**, R. Br.

- M. 218 .. .. 1. *lutea*, N.E. Br. .. .. r.Th.L.

**Duvalia**, Haw.

- M. 219 .. .. 1. *transvaalensis*, Schltr. .. .. v.r.Th.L.

## CONVOLVULACEAE, Vent.

**Evolvulus**, Linn.

- M. 241 .. .. 1. *alsinoides*, Linn. .. .. o.L.

**Convolvulus**, Linn.

- M. 236 .. .. 1. *hastatus*, Thunb. .. .. o.S.

**Merremia**, Dennst.

- M. 612 .. .. 1. *palmata*, Hall. f. .. .. o.S.R.

**Ipomoea**, Linn.

- M. 227 .. .. 1. *adenioides*, Schinz .. .. v.l.Th.  
M. 237 & 746 .. 2. *angustifolia*, Jacq. .. .. o.S.L.  
M. 234 .. .. 3. *angustisecta*, Engl. .. .. o.S.  
M. 229 & 742 .. 4. *crassipes*, Hook. .. .. a.L., o.R.  
M. 240 .. .. 5. *dissecta*, Willd. ? .. .. r.S.  
M. 744 .. .. 6. *magnusiana*, Schinz ? .. .. f.T.  
M. 231 .. .. 7. *obscura*, Ker .. .. o.L.S.  
M. 228 .. .. 8. *Ommanei*, Rendle .. .. o.L.S.  
M. 233 .. .. 9. *Papilio*, Hall. f. .. .. o.L.  
M. 225 .. .. 10. *simplex*, Thunb. .. .. o.L.Th.  
M. 238 .. .. 11. sp. near *I. digitata* .. .. o.T.  
M. 235 .. .. 12. sp. near *I. ovata* .. .. la.S.  
M. 239 .. .. 13. sp. (not in Fl. Cap.) .. .. o.S.  
M. 530 .. .. 14. sp. .. .. a.T.  
M. 743 .. .. 15. sp. .. .. a.L.  
M. 745 .. .. 16. sp. .. .. o.L.

## BORAGINACEAE, Lindl.

**Ehretia**, Linn.

- |        |    |    |                                 |    |    |             |
|--------|----|----|---------------------------------|----|----|-------------|
| M. 223 | .. | .. | 1. <i>caerulea</i> , Gurke      | .. | .. | o.L.        |
| M. 497 | .. | .. | 2. <i>hottentotica</i> , Burch. | .. | .. | f.L., o.Th. |

**Heliotropium**, Linn.

- |        |    |    |                                |    |    |        |
|--------|----|----|--------------------------------|----|----|--------|
| M. 224 | .. | .. | 1. <i>Eduardi</i> , Martelli   | .. | .. | l.a.T. |
| M. 501 | .. | .. | 2. <i>ovalifolium</i> , Forsk. | .. | .. | l.a.T. |

**Trichodesma**, R. Br.

- |        |    |    |                                 |    |    |              |
|--------|----|----|---------------------------------|----|----|--------------|
| M. 502 | .. | .. | 1. <i>angustifolium</i> , Harv. | .. | .. | l.f.R., o.L. |
| M. 504 | .. | .. | 2. <i>physaloides</i> , A.D.C.  | .. | .. | l.f.R., o.L. |

## VERBENACEAE, Juss.

**Lantana**, Linn.

- |              |    |    |                              |    |    |          |
|--------------|----|----|------------------------------|----|----|----------|
| M. 279 & 599 | .. | .. | 1. <i>salvifolia</i> , Jacq. | .. | .. | o.L.T.R. |
|--------------|----|----|------------------------------|----|----|----------|

**Lippia**, Houst.

- |        |    |    |                               |    |    |        |
|--------|----|----|-------------------------------|----|----|--------|
| M. 280 | .. | .. | 1. <i>asperifolia</i> , Rich. | .. | .. | o.L.S. |
| M. 753 | .. | .. | 2. <i>scaberrima</i> , Sond.  | .. | .. | l.L.   |

**Bouchea**, Cham.

- |        |    |    |                             |    |    |            |
|--------|----|----|-----------------------------|----|----|------------|
| M. 281 | .. | .. | 1. <i>hederacea</i> , Sond. | .. | .. | f.R., o.L. |
| M. 508 | .. | .. | 2. <i>sp.</i>               | .. | .. | r.L.       |

**Vitex**, Linn.

- |        |    |    |                               |    |    |            |
|--------|----|----|-------------------------------|----|----|------------|
| M. 640 | .. | .. | 1. <i>Poara</i> , Corbishley  | .. | .. | r.S.       |
| M. 282 | .. | .. | 2. <i>sp. near V. reflexa</i> | .. | .. | a.S., o.R. |

**Clerodendron**, Linn.

- |        |    |    |                                |    |    |            |
|--------|----|----|--------------------------------|----|----|------------|
| M. 284 | .. | .. | 1. <i>glabrum</i> , E. Mey.    | .. | .. | o.S.T.r.L. |
| M. 283 | .. | .. | 2. <i>ternatum</i> , Schinz    | .. | .. | f.L.       |
| M. 509 | .. | .. | 3. <i>triphyllum</i> , Pearson | .. | .. | o.R.       |

## LABIATAE, B. Juss.

**Becium**, Lindl.

- |        |    |    |                               |    |    |      |
|--------|----|----|-------------------------------|----|----|------|
| M. 510 | .. | .. | 1. <i>obovatum</i> , N.E. Br. | .. | .. | l.R. |
|--------|----|----|-------------------------------|----|----|------|

**Ocimum**, Linn.

- |        |    |    |                              |    |    |       |
|--------|----|----|------------------------------|----|----|-------|
| M. 285 | .. | .. | 1. <i>americanum</i> , Linn. | .. | .. | f.Th. |
|--------|----|----|------------------------------|----|----|-------|

**Orthosiphon**, Benth.

- |           |    |    |                              |    |    |      |
|-----------|----|----|------------------------------|----|----|------|
| M. 286    | .. | .. | 1. <i>affinis</i> , N.E. Br. | .. | .. | f.S. |
| Davy 1744 | .. | .. | 2. <i>Wilmsii</i> , Guerke.  | .. | .. |      |

**Plectranthus**, L'Herit.

- |        |    |    |               |    |    |         |
|--------|----|----|---------------|----|----|---------|
| M. 287 | .. | .. | 1. <i>sp.</i> | .. | .. | l.a.Th. |
| M. 288 | .. | .. | 2. <i>sp.</i> | .. | .. | l.a.Th. |

**Salvia**, Linn.

- |        |    |    |               |    |    |      |
|--------|----|----|---------------|----|----|------|
| M. 601 | .. | .. | 1. <i>sp.</i> | .. | .. | o.T. |
|--------|----|----|---------------|----|----|------|

**Acrotome**, Benth.

- |        |    |    |                            |    |    |      |
|--------|----|----|----------------------------|----|----|------|
| M. 602 | .. | .. | 1. <i>inflata</i> , Benth. | .. | .. | o.S. |
|--------|----|----|----------------------------|----|----|------|

**Leucas**, Burm.

- |        |    |    |                                  |    |    |            |
|--------|----|----|----------------------------------|----|----|------------|
| M. 290 | .. | .. | 1. <i>martinicensis</i> , R. Br. | .. | .. | f.L., o.T. |
|--------|----|----|----------------------------------|----|----|------------|

**Leonotis**, R. Br.

- |        |    |    |                               |    |    |      |
|--------|----|----|-------------------------------|----|----|------|
| M. 634 | .. | .. | 1. <i>microphylla</i> , Skan. | .. | .. | r.S. |
|--------|----|----|-------------------------------|----|----|------|

**Teucrium**, Linn.

- |        |    |    |                            |    |    |        |
|--------|----|----|----------------------------|----|----|--------|
| M. 291 | .. | .. | 1. <i>capense</i> , Thunb. | .. | .. | o.L.S. |
|--------|----|----|----------------------------|----|----|--------|

## SOLANACEAE, Hall.

**Lycium**, Linn.

- |         |    |    |                          |    |    |             |
|---------|----|----|--------------------------|----|----|-------------|
| M. 246a | .. | .. | 1. <i>tenue</i> , Willd. | .. | .. | f.Th., r.L. |
|---------|----|----|--------------------------|----|----|-------------|

				<b>Withania</b> , Pauquy.			
M. 595	..	..		1. <i>somnifera</i> , Dunal	..	..	Rud. r. in T. & L.
				<b>Physalis</b> , Linn.			
M. 246	..	..		1. <i>minima</i> , Linn.	..	..	Rud. f. in L. & o. in T.
				<b>Solanum</b> , Linn.			
M. 242	..	..		1. <i>incanum</i> , Linn.	..	..	Rud.o. in L.
M. 747	..	..		2. <i>nigrum</i> , Linn.	..	..	Rud. in L. v.r.
M. 243 & 594	..	..		3. <i>panduraeforme</i> , E. Mey.	..	..	Rud. in all Assoc. f.
M. 245	..	..		4. sp.	..	..	o.L.
				<b>Datura</b> , Linn.			
M. 750	..	..		1. <i>ferox</i> , Linn.	..	..	Rud.o.
M. 748	..	..		2. <i>stramonium</i> , Linn.	..	..	Rud.o.
				<b>SCROPHULARIACEAE</b> , Lindl.			
				<b>Aptosimum</b> , Bureh.			
M. 247	..	..		1. <i>elongatum</i> , Engl.	..	..	f.L.
				<b>Diclis</b> , Benth.			
M. 505	..	..		1. <i>petiolaris</i> , Benth.	..	..	o.V.
				<b>Sutera</b> , Roth.			
M. 531	..	..		1. <i>luteiflora</i> , Hiern	..	..	f.T.
M. 248	..	..		2. <i>pinnatifida</i> , O. Ktze	..	..	la.L.
				<b>Mimulus</b> , Linn.			
M. 250	..	..		1. <i>gracilis</i> , R. Br.	..	..	la.V.
				<b>Melasma</b> , Berg.			
M. 252 & 751	..	..		1. sp. ( = <i>Alectra Vogelii</i> , Bth.)	..	..	o.S., r.L.
M. 251	..	..		2. sp.	..	..	o.S.
				<b>Buchnera</b> , Linn.			
M. 253	..	..		1. <i>brevibractealis</i> , Hiern	..	..	o.S.
				<b>Rhamphicarpa</b> , Benth.			
M. 258	..	..		1. <i>tubulosa</i> , Benth., var.	..	..	r.S.
				<b>Striga</b> , Lour.			
M. 256	..	..		1. <i>elegans</i> , Benth.	..	..	o.L.R.
M. 709	..	..		2. <i>Forbesii</i> , Benth.	..	..	o.T.as Rud.
M. 257	..	..		3. <i>lutca</i> , Lour.	..	..	a. as Rud. in S.L.R., o. in T.
M. 254	..	..		4. <i>orobanchoides</i> , Benth.	..	..	r.S., f. as Rud. in asgrond.
M. 255	..	..		5. <i>Thunbergii</i> , Benth.	..	..	o.L.R.
				<b>SELAGINACEAE</b> .			
				<b>Selago</b> , Linn.			
M. 278	..	..		1. <i>hermannioides</i> , E. Mey.	..	..	f.S.
M. 769	..	..		2. sp.	..	..	la.S.
				<b>PEDALIACEAE</b> , Lindl.			
				<b>Pterodiscus</b> , Hook.			
M. 259	..	..		1. <i>speciosus</i> , Hook.	..	..	o.Th.
				<b>Harpagophytum</b> , D.C.			
M. 260	..	..		1. <i>Peglerae</i> , Stapf.	..	..	f.S., o.L.
				<b>Sesamum</b> , Linn.			
M. 261	..	..		1. <i>capense</i> , Burm.	..	..	o. as Rud. in S & L.
				<b>Ceratotheca</b> , Endl.			
M. 710	..	..		1. <i>triloba</i> , E. Mey.	..	..	o. as Rud. in T. & S.

**Petrea, J. Gay.**

- M. 262 .. .. 1. *zanguebarica*, J. Gay. .. .. o.S.; also as Rud.  
in it.

**LENTIBULARIACEAE, Lindl.****Utricularia, Linn.**

- M. 506 .. .. 1. *exoleta*, R. Br. .. .. o.V.

**ACANTHACEAE, Juss.****Thunbergia, Linn.**

- M. 263 .. .. 1. *atriplicifolia*, E. Mey. .. .. f.L.S.R.  
M. 264 .. .. 2. *dregeana*, Nees .. .. o.L.

**Ruellioipsis, C.B. Cl.**

- M. 267 .. .. 1. *setosa*, C.B. Cl. .. .. r.S.

**Ruellia, R. Br.**

- M. 265 .. .. 1. *ovata*, Thunb. .. .. f.L.Th.R.

**Crabbea, Harv.**

- M. 273 .. .. 1. *hirsuta*, Harv. .. .. o.L.S.R.  
M. 596 .. .. 2. sp. .. .. f.T.

**Barleria, Linn.**

- M. 514 .. .. 1. *jasminiflora*, C.B. Cl. .. .. f.Th.  
M. 270 .. .. 2. *Mackenzii*, Hook. f. .. .. o.L.Th.  
M. 271 .. .. 3. *Macrostegia*, Nees .. .. o.S.  
M. 272 .. .. 4. n.sp. near ,, .. .. o.S.

**Blepharis, Juss.**

- M. 266 .. .. 1. *molluginifolia*, Pers. .. .. o.S.Th.  
M. 269 .. .. 2. *squarrosa*, T. Anders. .. .. o.S.

**Crossandra, Salisb.**

- M. 787, 8859 .. 1. *Greenstockii*, S. Moore .. .. l.S.

**Peristrophe, Nees.**

- M. 277 & 597 .. 1. *natalensis*, T. Anders. .. .. o.T.S.

**Justicia, Linn.**

- M. 275 .. .. 1. *anagalloides*, T. Anders .. .. o.S.  
M. 507 .. .. 2. *Bowiei*, C.B. Cl. .. .. l.f.S.  
M. 274 .. .. 3. *flava*, Vahl .. .. f.Th., o.L.  
M. 276 .. .. 4. *pulegioides*, E. Mey. .. .. o.S.

**RUBIACEAE, B. Juss.****Oldenlandia, Linn.**

- M. 162 & 486 .. 1. *caffra*, E. & Z. .. .. f.S.Lc.  
M. 174 .. .. 2. *chlorophylla*, Hochst. .. .. f.S.  
M. 165 .. .. 3. *Heynei*, G. Don .. .. l.a.S.  
M. 163 .. .. 4. sp. near *O. stricta*, K. Schum. .. .. f.L.  
M. 164 .. .. 5. sp. = Schltr. 11574 .. .. Rud.f.  
M. 487 .. .. 6. sp. .. .. l.a.V.

**Gardenia, Ellis.**

- M. 166 .. .. 1. *Thunbergia*, L. ? .. .. r.S.

**Vangueria, Comm.**

- M. 168 .. .. 1. *infausta*, Burch. .. .. o.S.

**Electronia, Linn.**

- M. 643 .. .. 1. sp. .. .. r.S.

**Pachystigma, Hochst.**

- M. 170 .. .. 1. *Cienkowski*, K. Schum. .. .. f.S.  
M. 169 .. .. 2. *Zeyheri*, Hiern. .. .. f.S.

**Pavetta, Linn.**

- M. 167 .. .. 1. *assimilis*, Sond. .. .. r.L.Th.



**Erigeron**, Linn.

- M. 183 .. .. 1. *canadense*, Linn. .. .. o. as Rud.

**Felicia**, Cass.

- M. 179 .. .. 1. *muricata*, Nees, var. *fascicularis* o.L.

**Nidorella**, Cass.

- M. 182 .. .. 1. *depauperata*, Harv. .. .. o.S.  
 M. 181 .. .. 2. *resedaefolia*, D.C. .. .. o.S., v.a. as Rud.  
 in S. & L.

**Tarchonanthus**, Linn.

- M. 184 .. .. 1. *camphoratus*, Linn. .. .. o.L.S.

**Blumea**, D.C.

- M. 489 .. .. 1. *gariepina*, D.C. .. .. f. as Rud. in L.  
 & S.

**Denekia**, Thunb.

- M. 185 .. .. 1. *capensis*, Thunb. .. .. a.V.

**Epaltes**, Cass.

- M. 180 .. .. 1. *gariepina*, Steetz .. .. a.V.

**Amphidoxa**, D.C.

- M. 186 .. .. 1. *gnaphaloides*, D.C. .. .. f.V.

**Gnaphalium**, Linn.

- M. 188 .. .. 1. *undulatum*, Linn. .. .. o.S.

**Helichrysum**, Vaill.

- M. 187 .. .. 1. *argyrosphaerum*, D.C. .. .. a. as Rud. in S.  
 & L.  
 M. 696 .. .. 2. *nudifolium*, Less. .. .. o.S.  
 M. 735 .. .. 3. *subglomeratum*, Less. .. .. l.Th.

**Geigeria**, Gries.

- M. 790 .. .. 1. sp. .. .. v.r. as Rud.

**Xanthium**, Linn.

- M. 788 .. .. 1. *spinosa*, Linn. .. .. r.Rud.  
 M. 736 .. .. 2. *strumarium*, Linn. .. .. r.Rud.

**Wedelia**, Jacq.

- M. 196 .. .. 1. *natalensis*, Sondl. .. .. la.T.

**Bidens**, Linn.

- M. 789 .. .. 1. *pilosa*, Linn. .. .. la. Rud.  
 M. 197 .. .. 2. *Schimperii*, Schult. ? .. .. o.S.

**Schkuhria**, Roth.

- M. 190 .. .. 1. *bonariensis*, H. & A. .. .. la. Rud.

**Tagetes**, Linn.

- M. 191 .. .. 1. *minuta*, Lam. .. .. lf.Rud.

**Pentzia**, Thunb.

- M. 192 .. .. 1. sp. .. .. o.Th.

**Senecio**, Linn.

- M. 492 .. .. 1. *fulgens*, N.E. Br. .. .. o.Th.  
 M. 490 .. .. 2. *latifolius*, D.C. var. .. .. o.S.  
 M. 193 .. .. 3. *orbicularis*, Sondl. .. .. r.S.  
 M. 491 .. .. 4. *pleistocephalus*, S. Moore .. .. o.Th.  
 M. 631 .. .. 5. *radicans*, D.C. .. .. o.Th.  
 M. 765 .. .. 6. *rhyncholaenus*, D.C. .. .. o. Rud.  
 M. 194 .. .. 7. *Serra*, Sondl. .. .. o.V.  
 M. 195 .. .. 8. sp. near *S. latifolius* .. .. o.V.  
 M. 529 & 766 .. .. 9. sp. .. .. f. as Rud. in  
 L. & T.



<b>Tripteris, Less.</b>				
M. 737 & 738 ..	1. <i>flexuosa</i> , Harv. ..	..	..	as Rud. f. in T & o. in L.
<b>Berkheyopsis, O. Hoffm.</b>				
M. 739 .. ..	1. <i>echinus</i> , O. Hoffm. ..	..	..	r.L.
<b>Berkheya, Ehrh.</b>				
M. 198 .. ..	1. <i>Radula</i> , O. Hoffm. ..	..	..	o.V.
<b>Platycarpha, Less.</b>				
M. 534 .. ..	1. sp. ....	..	..	o.V.
<b>Dicoma, Less.</b>				
M. 200 .. ..	1. <i>anomala</i> , Sond. ....	..	..	f.S.
M. 199 .. ..	2. <i>macrocephala</i> , D.C. ..	..	..	o.R.S.L.
<b>Gerbera, Gron.</b>				
M. 708 .. ..	1. sp. near <i>G. viridifolia</i> = <i>Dieterlin</i> 168 .. ..	..	..	r.S.
<b>Sonchus, Linn.</b>				
M. 767 .. ..	1. <i>oleraceus</i> , L. ....	..	..	o.Rud

## PLANT SUCCESSION.

The most marked feature of the plant succession is the steady increase of arborescent vegetation, more especially of Acacias, which appear to be particularly well adapted to the deep basaltic loams and, to a lesser extent, to the turf soils. Climatic conditions are also favourable.

The indications are that Acacia trees will eventually spread over the whole Flats, which are steadily being invaded by them from all sides. This increase appears to have been greatly accelerated by the advent of farmers of European origin. Places that eight years ago were grassy fields, with a few Acacias scattered about, are now being thickly overgrown with young Acacias.

The cause of this acceleration appears to be the restriction of grass fires.

Acacia seeds germinate very slowly, unless either heated by grass fires, or passed through the bodies of animals eating their pods. In the latter connection the large number of Acacia seedlings springing up in lands fertilised with manure from goat and sheep kraals is very noticeable.

Of those seeds not subjected to either of the above processes, the greater number are probably destroyed by insects during the long period they require to remain on the ground before germination takes place.

There has not been any such marked increase in the number of animals feeding upon Acacia pods during recent years as would account for the increased number of plants growing up, since previously, in addition to a considerable number of flocks belonging to natives, the flats were tenanted by vast herds of springbok and other antelopes. The conclusion therefore appears to be warranted that the recent more rapid spread of Acacias is due solely to the restriction of grass fires. In former years it was the custom of natives to burn the veld annually, and on these uninterrupted plains, densely clothed with tall grasses, a few fires once started, and not checked, will quickly spread over the whole Flats. The result was that seedling Acacias, whether germinated as a result of the preceding year's grass fires or otherwise, were annually subjected to burning before they were a year old and very few survived.

Under present conditions, when every effort is made to check grass fires, it may be several years before the same piece of veld is burned (it has not been found possible to stop all grass fires) by which time the greater number of seedlings would be strong enough to resist the heat of grass fires.

This steady invasion of the pasturage by Acacia and other trees, owing to the restriction of veld burning, presents a very puzzling problem as to whether such restriction is beneficial or otherwise.

The presence of scattered trees in the veld is wholly beneficial, not only as affording shade and shelter to stock, but also because many of our sweetest and most fattening grasses, such as *Panicum maximum* and allied species included under the general name of *Buffelsgras*, *Urochloa* spp., and *Pennisetum cenchroides* (Lidjesgras), form dense thickets under their protection and afford the best grazing.

It is quite a different matter, however, when the number of trees increase to such an extent as to form a jungle, and it is to this that evolution in Acacia veld is tending.

Annual veld burning will prevent this, and is also of very great service in destroying ticks, grasshoppers, beetles, and other pests.

As a set-off against these advantages, is the fact that it undoubtedly destroys the surface humus and thus impoverishes the soil, as well as causes a larger proportion of rainfall to run off, instead of soaking into the ground, leading to erosion and the formation of dongas.

This latter drawback, however, scarcely applies to the Springbok Flats, the greater portion of which is so level that there is no run-off, and all rain falling soaks into the ground, even when the veld has been burned.

It may be argued that the practice of burning the veld before the advent of the Spring rains has been going on in this area for generations under native occupation, and that the present fertility of the soil is evidence that the amount of humus so destroyed is little, if any, greater than the amount replaced each year by fresh growth. Whether this be so or not, veld burning certainly prevents the continual betterment of the soil which would otherwise take place.

By restricting veld burning and allowing the pasturage to develop into an *Acacia* thicket, the soil will certainly be steadily enriched, but at what cost?

*Acacias* so grown are shrubby and scraggy, without value, and are simply useless weeds encumbering the ground. The pasturage is greatly impaired by them; cattle cannot get into the dense thickets, whilst the covering of grass gets thinner and thinner according to the density of the growth. As to the enriched soil, the cost of clearing such jungle-grown ground for agricultural purposes is prohibitive, excepting it can be brought under water and valuable irrigation crops grown upon it.

Though deploring the destruction of humus by veld burning, which in many parts of the Union is an unmitigated evil, as, for example, on the mountain slopes of the South Western Districts, there are certain types of veld in which *Acacias* form the climax vegetation, where the practice of annual veld burning appears to be justifiable, as being the lesser of two evils and the only practicable method under present conditions by which the plant succession can be retarded and the veld saved from being completely overgrown with *Acacias*.

The burning of the vegetation on the deep, loose soil of the Sandveld proper is quite a different matter. It is not an *Acacia* veld and in my opinion nothing can warrant it. The soil is so poor that it does not pay to cultivate, whilst the scanty grasses it carries are very coarse and only fit for grazing during the rainy season, when they have some succulence and are the earliest to put on new growth. During this season the porous, sandy soil also makes it beneficial to move stock on to it from the sodden loams.

Owing to its porous nature, the loose, sandy soil dries out very quickly and before winter sets in the surface vegetation becomes harsh and dries out and is practically useless for grazing.

To remedy this and at the same time improve the quality of the grasses, and fit the soil for cultivation, the accumulation of a more adequate supply of humus is imperative. The soil is mostly deep, and, where this is the case, carries a rich arborescent vegetation, composed of Sering (*Burkea*), *Vaalbos* (*Terminalia*), *Pijpsteel* (*Viter*) and other trees, and, if the veld be only left unburned, humus would steadily increase and enrich the soil.

A further most cogent reason for the stringent restriction of veld burning in the Sandveld areas is that, owing to the sand ridges being higher than the surrounding country, after the burning of the veld before the onset of the rainy season, the loose sand is not only blown by the strong winds which prevail at that time of the year, but the rains, which frequently set in with a downpour of several inches, wash the sand loosened by the burning on to the surrounding veld, and thus, by the agency of both wind and rain, the Sandveld area is being steadily enlarged.

Examples of this eneroachment of the Sandveld area on to the basaltic loam soils are everywhere to be seen. For instance, on the farm Zyferkraal, sand carried down from the sand ridge on the Vogelfontein boundary has in places completely buried the black turf soil at its base, giving it the appearance of Sandveld, whilst along the south eastern side of Roodepoort you find light sandy soil, carried from the Mooihoekspoort sand ridge, superimposed upon a subsoil of decomposed basalt.

This steady spreading of the Sandveld area is a most serious matter and every effort should be made to prevent it.

Unfortunately, at present practically the whole of the Sandveld area is burned out every season by natives and others and so long as this continues improvement is hopeless.

#### SUCCESSION IN THE BLACK TURF ASSOCIATION.

This grassland association is being steadily invaded by trees, chiefly *Acacias*, on all sides from the adjoining Basaltic Loam and Rooibos associations. Trees from neighbouring Sandveld areas are evidently unsuited to black turf conditions and show no signs of eneroachment.

The chief invading trees are: *Acacia litakunensis* (Haakensteek), *Acacia Benthami* (Lekker-ruik-peul), *Acacia Gerrardi* (Aapkop) and *Acacia karroo* (Sweet Thorn). Here and there, considerable groves of one or other species have already been formed, for the most part close to the outside boundaries of the association, whilst isolated scattered seedlings are to be found as pioneers sprinkled far and wide in the central grasslands.

The curious stoloniferous dwarf *Acacias*, *A. permixta*, var. *glabra*, and *A. natalitia*, forma *stolonifera*, collectively known as "Fijndoor," found growing only in the black turf and widely spread all over the grasslands, also appear to be steadily increasing in number.

Other trees and shrubs gradually making their appearance, mostly as young seedlings, are *Rhus pyroides* (Taaibos), *Rhus lancea* (Karee), *Rhus Engleri* *Zizyphus mucronata* (Blinkblaar Wachteenbietjie), *Royena pallens* (Blauwbos), *Grewia* n.sp.? (Galpin No. M39), *Gymnosporia buxifolia* (Pendoorn) and *Clerodendron glabrum*.

Amongst smaller plants, the gay, yellow-flowered composite, *Wedelia natalensis*, is over-running portions of the veld, here and there, in the older occupied areas, and should be exterminated. If allowed to spread, the grazing over large areas may become seriously impaired.

*Heliotropium Eduardi* and *H. ovalifolium* also seem inclined to spread in the neighbourhood of cultivated lands.

Around homesteads, the Khakibos (*Alternanthera Achyrantha*) has established itself on some farms, whilst on others the Mexican Marigold (*Tagetes minuta*) has made its appearance, but I do not think either plant is likely to prove a serious pest in this area.

*Ipomoea* sp. (Galpin No. M.530) is by far the most abundant weed in cultivated lands, where other common and troublesome weeds are: *Bidens pilosa* (Black Jack), *Physalis minina* (Wild Gooseberry) and various species of *Cucurbitaceae*.

Occupation and cultivation are greatly improving the pasturage by the spread of sweet grasses of good feeding value, such as various species of *Urochloa*, *Brachiaria* and *Panicum*, *Chloris virgata*, *Sorghum versicolor*, *Pennisetum cenchroides*, *Fingerhuthia Africana* and *Eragrostis* spp.

#### SUCCESSION IN THE BASALTIC LOAM ASSOCIATION.

On basaltic loam soils, *Acacia karroo* (Sweet Thorn) appears to be a comparatively recent addition to the flora, judging by the absence of old trees, but has now become one of the dominant trees. It is increasing the

most rapidly of all, and over-running considerable stretches of veld, which only seven or eight years ago consisted of grasslands, dotted here and there with a few scattered trees.

*Acacia litakunensis* (Haakensteek) is also increasing rapidly, though not nearly so fast as *A. karroo*. It is one of the pioneer trees on the Flats and many fine old specimens are to be found in the more wooded portions of the basaltic loam area, where numerous young trees are springing up and thickening the growth. It is continuing to spread throughout the basaltic, red, heavy loams and into the black turf as well, and is steadily invading the inner grasslands, all over which, here and there, at more or less distant intervals, one comes across young pioneer seedling plants.

On the other hand, *Acacia robusta* (Oudoorn), also one of the early pioneers, is making no further headway. Whilst old trees, many of them long past their prime, are not uncommon, comparatively few young ones are to be met with.

A few old trees of *Acacia retinens* (Zwarthaak) and of *Acacia giraffae* (Kameeldoorn) indicate that these trees found their way on to the basaltic loams generations ago, but have made no headway. Very few young plants of the Zwarthaak are to be found, and those are very local, although it continues to reproduce itself freely in the Thomboti association. As regards the Kameeldoorn, I have not found any young trees and it seems likely to die out in this association, though the old trees bear heavy crops of seed every year.

*Dichrostachys nutans* (Sikkelbos) thrives in light, sweet, sandy loams, and, in many places where the basaltic loams have been largely admixed with sand, is increasing enormously and forming dense jungles of thorny growth, particularly in places where old lands have gone out of cultivation. It does not thrive in light sandy soils of an acid type and is very rare in the Rooibos association.

*Combretum rhodesiacum* (Kierieklapper), the only member of this typical zuurveld genus to be found in the basaltic loams, shows good re-production and is steadily increasing, though not with anything like the rapidity of *Acacia karroo*, *A. litakunensis*, or *Dichrostachys nutans*.

*Boscia rehmanniana* (Witgat), a curious tree of a desert type, closely allied to other species of *Boscia* growing in Gordonian and the South West Protectorate, appears to be fast dying out. Mature trees, many of them of very great age, are locally frequent in basaltic loam soils and seed abundantly, yet I have never succeeded in finding a young plant there, whilst in the Thomboti association, where they are much more abundant and also seed very freely, young plants are extremely rare and you may search in the midst of them for hours without discovering a single specimen.

When one considers the immense ages through which such ancient plants as *Welwitschia*, *Gnetum*, *Stangeria* and *Eucephalartos* have survived in other parts of Africa, south of the Equator, there seems to be nothing improbable in the possibility of this remarkable tree being locally a survival from a past age when desert conditions prevailed in this area as referred to by Dr. P. A. Wagner in the very interesting chapter on the Geology of the Flats contributed by him to this Memoir, in the concluding part of section 4, "Superficial Deposits."

Amongst shrubs, a dwarf species of *Gymnosporia* (Galpin No. M.55) is steadily spreading and, in places where the veld has been tramped out, is forming small but dense consociations. *Grewia* n.sp.? (Galpin No. M.39) also appears to be on the increase, whilst young plants of *Royena pallens* (Blauwbos) in many places are springing up in quantity. The latter are quite new-comers in the basaltic loam and black turf and are probably pioneers from the Thomboti association, on the borders of the Nyl, where it has been long established.

A full account of the spread of ruderal grasses and weeds is given in the general description of the flora of the association.

#### SUCCESSION IN THE SANDVELD ASSOCIATION.

The most striking feature in the Sandveld is the enormous number of young trees of *Terminalia sericea* (Vaalbos) springing up in many localities and often forming considerable consocieties, making it evident that this tree will in a short time obtain complete dominance over all others.

*Vitex* sp. (Galpin No. M.282; Pijpstee) is also increasing at a very rapid pace and, when the young seedlings now coming on grow up, is likely to rank second to the above in order of frequency.

*Ochna pulchra* (Zeerbos or Lekkerbreek), judging by the large number of young seedlings one sees, is another tree showing a considerable prospective increase.

On the other hand, *Burkea africana* (Sering), one of the dominant and most valuable trees, is showing very poor re-production and seems likely to decrease in number as time goes on, so that when the present mature trees have gone, it is likely to become a much less frequent tree on the Flats.

Amongst shrubs, *Grewia caffra* (Rozijntjebos) is increasing the most rapidly and in many places is forming small consocieties.

There is little change noticeable in the grasses beyond the continued spreading of *Cyndon Dactylon* (Kweek) as a ruderal.

#### SUCCESSION IN THE ROOIBOS ASSOCIATION.

In a few places large numbers of young plants of *Combretum apiculatum* and *C. Guerinii* are growing up, otherwise there is little indication of change in this association.

#### SUCCESSION IN THE THOMBOTI ASSOCIATION.

This remains practically virgin ground and there are no present indications of any coming change in its vegetation beyond the extreme rarity of young plants of *Boscia Rehmanniana*, one of the commonest plants in the association, indicating that it is in process of extinction, as already commented upon with reference to plant succession in the basaltic loam.

#### SUCCESSION IN THE VLEI ASSOCIATION.

A very noticeable feature in this Association is the rapid spread of *Oryza sativa* (rice), which now covers considerable areas in the Nyl Vlei on the farms Zyferkraal and du Toit's Kraal, where prior to the 1917 floods, when the Nyl Vlei was turned into a lake, in places two miles broad and up to five feet deep, there were only a few small patches. It is impossible to say whether or not this great increase of *Oryza* is merely a periodical fluctuation, such as takes place in the proportion of sedges to grasses according to whether seasons of excessive rainfall or of drought prevail, as referred to in the general account of the flora of this Association. The years 1910 to 1914 were exceedingly dry ones, so much so that the greater portion of what is looked upon as the marshy area of the Vlei was ploughed up and put under crops by natives, and this might well be the cause of the rice plants being confined to a few small patches in the river channel when they first came under my observation.

*Panicum laevifolium* tends to spread and to replace the original grass on land that has been cultivated. The latter is mostly *Themeda triandra*, which is dominant on the drier areas that are usually selected for cultivation.



PL. 1. Succession in the Black Turf.

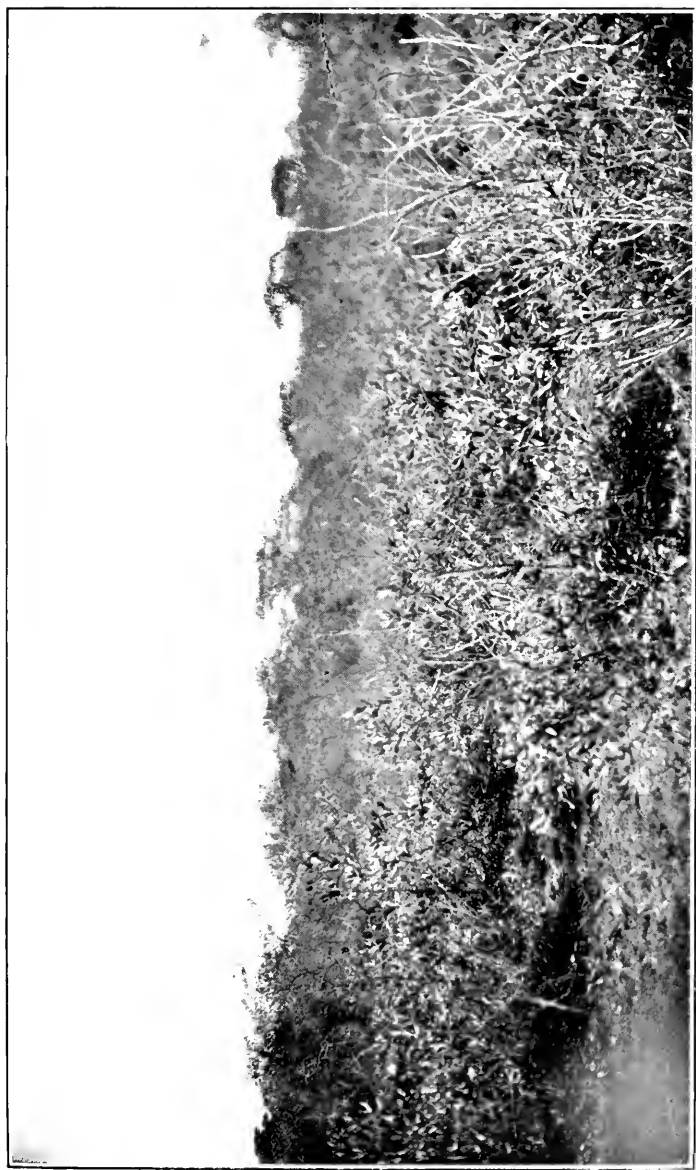
Seedlings of *Acacia B. albanica* invading the grasslands on farm Goluk.

*Photo by E. E. Galpin.* 21 5 25.



Plant Succession in the Basaltic Loam Association. Seedlings of *Acacia karoo* invading the grasslands on farm Roo-de-poort.  
Photo by E. E. Galpin, 22/5, 25.





Plant Succession in the Sandveld. Seedlings of *Terminalia sericea* invading the veld. *Burkea africana* in the far background.  
On farm Rooilepoort.

Photo by E. E. Galpin, 22.5.25.



## ECONOMIC RESOURCES.

## CROPS.

With a summer rainfall averaging about 25 inches combined with a variety of soils of great depth and more than average fertility the Springbok Flats are admirably suited for the growth without irrigation of most summer crops and have gained an excellent reputation for the superior quality of their products.

The level nature of the ground enables the whole rainfall to soak in without loss, so that there is practically no run-off and no erosion, with the result that dongas are unknown. Owing to this and to the entire absence of stones fully three-quarters of the area, comprising the most fertile soil, can be ploughed and brought under cultivation in blocks of any desired size or shape with no other expense than the clearing of scattered trees and bushes and with very little even of the latter over considerable stretches of grassland in the central portions.

The following are the principal crops at present being grown :—

*Maize.*

This forms by far the largest crop, the popular varieties being " Hickory King " and " Ladysmith White," for which local conditions have been found to be the most suitable.

It is grown with success on all the local soils, of which " black turf " is the most popular, chiefly owing to its immunity from Rooibloem infestation and its great water capacity, which enables it to remain sufficiently moist beneath the surface to permit of ploughing at any time throughout the dry season. This is further assisted by the fact that, probably owing to its high lime content, it dries into a friable condition, forming a natural muleh, and does not become hard and baked and puddled like some other so-called turf soils. With the long ploughing season thus made possible a much larger area per plough can be brought under cultivation than is possible in the red loams. Another advantage is that owing to their friable nature the black turf soils are about the easiest possible to weed ; the slightest pull will remove any weed, roots and all. Thus, a land infested with, say, full grown black jacks (*Bidens*) or pigweed (*Amarantus*) to such an extent that would probably mean its abandonment for the season in any other soil, can be weeded economically by hand-pulling and more easily than by using hand hoes.

On the other side, the disadvantages of the black turf soils are that they require a considerably heavier rainfall than any of the others before becoming moist enough for the germination of seeds and with too heavy a rainfall remain too wet to work for a material period owing to poor drainage capacity. Thus, the requirements for good germination of seed are somewhat narrow and in seasons of low rainfall crops may be obtained on the red loams and sandy soils when those on the black turf fail, whilst in seasons of heavy rainfall, owing to the flooding of the land, it is often necessary to replant it, and sometimes to replant again, before a successful germination can be obtained, occasionally resulting in a crop being kept back until it is too late in the season for the best results. However, this is not altogether an unmixed evil, as it is owing to this difficult germination that the minute seeds of the parasitic " Rooibloem " (*Striga lutea*) have so little chance, with the result that black turf lands enjoy such an immunity from this destructive root parasite that they may be continuously planted with maize year after year without becoming infested with it.

In all other respects the black turf soils are of the best quality and in fair average seasons, without the application of any fertiliser, will yield first-class crops year after year.

The varietal form of black turf known as "Asgrond" or "ash-ground," because of the grey colour imparted to it by a heavy admixture of lime, is much looser in texture. Owing to this, it is better drained and has much better germinating qualities, but loses the immunity to Rooibloem infestation.

The basaltic red heavy loam is practically equal in richness to the black turf, though the availability of its phosphoric oxide is lower, and the chief distinction is in the great difference between the water capacity and volume expansion of the two classes of soil. These qualities vary considerably in different varieties of red basaltic loam, but the average according to Dr. Marchand (see his report in the chapter on soils) is, respectively, 66.7 and 37.8 for black turf and only 42.1 and 7.2 for basaltic red heavy loam soils. The latter have much the better germinating qualities and also require a smaller rainfall to bring about optimum water conditions—both very great advantages—but with them comes the liability of maize and other grass crops to serious injury from the root parasite known as "Rooibloem" or "Witchweed" (*Striga lutea*) unless kept in check. (For further information regarding this destructive plant and the steps recommended for dealing with it, see the chapter on the Basaltic Loam Plant Association sub-heading "Ruderal Weeds").

The basaltic red heavy loams contain almost as much clay as the black turf, the average of the soils analysed by Dr. Marchand being, respectively, 43.3 per cent. and 46.6 per cent., and with so slight a difference it is difficult to understand why it is that they do not get nearly so sticky as the black turf and that their volume expansion is so very much smaller. Is it possible that the much greater percentage of ferric oxide and alumina is the cause of the latter?

Whilst old and well worked lands of the heavier varieties, such as the chocolate and darker reds, are frequently ploughable all through the dry season until the arrival of the spring rains, virgin soils and the lighter varieties of the red basaltic loams usually become too hard to plough after the end of August, but, in common with the red and grey sandy soils, this last season has conclusively shown that these lighter varieties can produce a crop on far less rainfall than that required by the heavier soils.

With good cultivation and constant vigilance to prevent Rooibloem from getting the upper hand, the red basaltic loams yield very regular and good crops equalling those on the black turf. Red loam lands that have been ten years under cultivation without fertilising are yielding better crops now than when first brought under cultivation.

The red sandy soils of the Rooibos Association and the better class grey sandy soils of the richer Sandveld area are of lower fertility and water capacity, but of excellent mechanical composition for plant growth. They give very poor returns without an application of fertiliser, but given the latter, give excellent crops.

The mealie stalk borer, so destructive in many parts of the Union, is unknown on the Flats.

The remarks made regarding the behaviour of the different soils under cultivation apply also with respect to the other crops described.

#### *Peanuts :*

"Virginia Bunch" peanuts are largely grown as being a profitable crop and excellent rotation for maize. The most suitable soils are : Asgrond, the red loams and the red and grey sandy soils, in all of which

they do well. Of these, the Asgrond and the dark chocolate coloured basaltic loams are considered the best. Up to the present, in every instance tried, the direct fertilising of this crop has proved a failure, the effect being to give a tremendous growth of top to the detriment of the nuts, which are largely "pops" i.e. badly filled shells with small or immature kernels.

There is an unlimited market for the nuts which form a regular portion of the rations for natives on the mines and are in demand for confectionery purposes, for oil extraction and for export.

Unfortunately, the plants are subject to a virus disease, known as "rosette" caused by an ultra-microscopic organism in the sap, which is conveyed from plant to plant by the agency of a small sucking insect, the *Aphis leguminosae*. The plants have a certain amount of immunity against this disease and in good seasons, when they are well nourished and making good growth, they have sufficient resistance to keep it in check and are unaffected by it, but in untoward seasons, when the vitality of the plants has been weakened by drought or other cause, the disease is apt to cause serious loss and sometimes ruins the whole crop. Were it not for this, the crop would be as largely grown as maize, as, apart from the value of the nuts, the roots are great nitrogen formers and enrich the soil, whilst the plants make a palatable hay, rich in protein and valuable as a substitute for lucerne. Experiments are now being carried out by the Division of Botany with a view to finding, if possible, some effective method for controlling the disease.

#### *Cotton :*

This crop has only been seriously grown on the Flats during the past two years and is more or less still in the experimental stage. "Improved Bancroft" is the variety grown. It is a good drought resister and during the present (1926) season, when maize and other crops have failed from drought, is actually giving heavier yields owing to the stunting of the plants bringing them earlier into flower. It grows well in the basaltic loams and red and grey sandy soils and seems likely to find a useful and permanent place in the crop rotation. Excepting on one or two farms where the yields have been poor, owing either to boll worm trouble or to the shedding of the squares, thought to be due to the excessive rains of the 1925 season, profitable and encouraging crops have been reaped and there has been no boll worm infection of any account on the majority of farms and a great freedom from jassid, which is practically unknown.

The growing season is somewhat short for optimum results, since the seed cannot be planted till November, summer rains only setting in towards the end of October, whilst the first frost may be expected about the 23rd. May, when many bolls are lost owing to not being sufficiently matured. This does not apply to the warm sand belts, where there is little or no frost and the season is much longer. However even with the drawback of a short season crops running up to 900 lbs. per acre, and 1,044 lbs. seed cotton on one test acre, in red basaltic loam have been obtained.

The tendency, except on sandy soil, seems to be towards growth at the expense of yield by retarding the time of flowering. The plants frequently grow six to eight feet high and though flowering heavily most of the bolls are formed too late. Possibly "topping" the plants when 2 ft. 6 in. or 3 ft. high may be of benefit by forcing them earlier into flower.

From the success of an experimental planting, it now seems likely that better results and a longer season can be obtained by planting the seed towards the end of the summer and allowing the plants to stand over the winter and come into flower with the first spring rains. Further plantings

have now been made to test this method next season and, if found satisfactory, cotton is likely to become a very important and useful crop in this area. There will be not only the gain of a longer season and consequent larger crop, but the cotton lands can be ploughed and planted during the slack season, after the maize and peanut crops have been thoroughly established, when there is little other work for the farm-hands and ploughing oxen and implements would otherwise be idle.

#### *Bean crops.*

All varieties of table beans, such as "Canadian Wonder," "Painted Lady," etc., grow well in all soils, yield satisfactory crops, and can be planted after the maize and other crops requiring a long season are in. The usual method employed locally to thresh beans is to beat the pods with sticks, but this and other methods of hand-threshing are found to be too slow and too expensive to make bean crops profitable. On this account table beans are not being grown at present as a commercial crop, which is a very great pity, as given threshing facilities, they could be grown with profit and with great benefit to the land. Owing to their valuable action in enriching the soil with the nitrogen nodules formed on their roots (nitrogen is the most expensive of all fertilisers) it is of great advantage to be able to include a bean or similar leguminous crop in the rotation and more particularly so when it can be made to yield a direct profit at the same time.

Unfortunately, bean threshing machines are much too expensive for the individual farmer to purchase and since, for the reason given, table beans are not grown as a crop, there is no present inducement for anyone to take up bean threshing on the Flats as a business. Yet, if threshing facilities were available, a crop which offers so many advantages is bound to be largely grown.

Other beans, such as Tepary Beans, Mung Beans, Velvet Beans, the so-called "Cow Pea" and Dhal, all of which make excellent growth and yield well, are grown to a certain extent as rotation crops. They are either fed to dairy and other animals, or ploughed in for green soiling, leaving only a sufficient reserve to supply the seed required for next season's planting or for sale for planting purposes. The farming industry on the Flats has been too recently started, in all but the neighbourhood of Settlers, for the establishment of dairying on any but a very small scale so that the demand for leguminous hay crops is insufficient to supply the quantity needed to be grown to furnish the best crop rotation.

#### *Tobacco.*

Tobacco growing is capable of great development on the Flats, the red and grey sandy soils and red loams offering a great variety of soils suitable for its culture, and were very favourably reported on by Mr. Scherffius, late Chief of the Tobacco and Cotton Division.

To grow it on a commercial scale requires a special training, the erection of suitable drying sheds and a special business to be made of it. The Settlers on the Flats being all maize growers, no one has so far taken it up.

The plant locally does exceedingly well. Many farmers grow it in a small way for home use and to sell to natives, and the crop has been sufficiently tested to show that it carries great possibilities and that good tobacco can be grown.

#### *Kafir Corn.*

Very large crops of kafir corn are grown by natives on the Flats with whom it is in great demand for beer-making and also as an article of diet. It is one of the most drought resistant crops we have, considerably more

so than maize, and is a very regular yielder. It is very subject to a rust disease but this does not appear to affect the yield to any serious extent, unless unusually severe. Birds are very partial to the grain and kafir corn lands attract small grain-eating birds in large swarms, so that natives find it necessary constantly to keep their children in their lands to scare the birds away. European farmers do not find it as profitable a crop as maize and find the engaging of children as bird scarers a matter of difficulty and expense and seldom grow it.

#### *Other Millets.*

Natives also grow several other millets much inferior to kafir corn and never grown by Europeans.

*Caution—Kafir corn poisoning.*—Kafir corn and other sorghum plants after the crop has been reaped and the stems ripened and fallen, often send up from the rootstock during the winter and early spring a young growth of green and succulent leaves containing prussic acid in toxic quantities. At this time of the year, when the fields contain no other herbage, this succulent growth has an irresistible attraction for livestock of all kinds, and is frequently the cause of the mysterious and very sudden death of healthy cattle and other animals. Old native lands and wherever kafir corn has been grown should be carefully searched at this time of the year and the young growth destroyed.

#### *Fodder Grasses.*

*Boer Manna* is wonderfully well suited to local conditions and can always be relied upon to yield a good crop. It is very nourishing and all animals seem particularly fond of it, even preferring it to oat-hay. It is an excellent crop to grow on mealie lands which have become infested with "Rooibloem" seed for the purpose of eradicating it. For this purpose it must be cut when the Rooibloem comes into flower and the stubble ploughed in.

*Sudan Grass* grows well and is very free from the cryptogamic disease it is reported to be liable to in some other localities. In good soils it will attain a height of nine feet. Whilst yielding a large quantity of fodder of considerable value, it is not nearly so palatable as boer manna.

*Napier Fodder and Babala Grass.*—These are very large perennial grasses of much the same description and are both well suited to local conditions. If left they will form dense thickets, 10 or 12 feet high, when the stems become very coarse and reed-like. They are better kept short by cutting from time to time, when they will furnish an immense quantity of fodder of good feeding value. They are frequently planted in rows to form breakwinds.

*Teff* grows well here once it is established, but is liable to be burned up during the first few days after germination unless rainy or cool weather prevails at the time, and in that case has to be re-sown. The best method of securing a good germination is to sow it when the land is dry. It makes good hay and is of value for combating Rooibloem owing to its extremely fine roots, which cover the ground so closely that there are few places where the Rooibloem seeds infesting it are too far from them to germinate. It is not so well suited to local conditions as it is to the Highveld, and I consider the following grasses described, which possibly would not do so well on the Highveld, better than it in every respect as fodder plants and should be grown in preference to teff in this area.

*Panicum laevifolium* is the best hay grass for local conditions that I know of and should take the same place on the Flats that teff does on the Highveld. It is the best of the "buffels" grasses, all of which are noted

for their excellent fattening properties, grows six feet high and furnishes an abundance of very palatable hay. Even when dry and cut down by frost, the dead grass remains palatable and is relished by stock. It is very easy to germinate, is a hardy and quick grower and will readily establish itself as a ruderal. It is indigenous to the Nyl Vlei and grows well in the other soils.

*Urochloa n.sp. (Galpin, No. M.673).*—This is a perennial grass closely allied to the buffels grasses. It is indigenous to the chocolate and red basaltic loams on the Flats, thrives under cultivation and readily establishes itself as a ruderal in cultivated lands and along their margins. It makes a dense leafy growth about three feet high and has all the palatable and fattening qualities of the buffels grasses. It makes a denser growth than *Panicum laevifolium*, but does not attain the same height. Whilst the latter is the better hay grass, it is perhaps the better of the two as a pasture grass, and if required can be grown as an annual.

*Brachiaria brizantha* belongs to the same group as the two last described grasses, all of which were until recently placed in the genus *Panicum*. Like them, it is very palatable and of first class feeding value. It is indigenous to the Nyl Vlei where it grows very luxuriantly, and is also found, in a stunted form, as an occasional grass in poor sandveld soils. It makes luxuriant growth under cultivation, is very suitable both for hay-making and for pasturage, and will probably thrive under poorer conditions than either of the two last mentioned.

*Pennisetum cenchroides (Lidjes gras).*—This is indigenous to the basaltic loam, asgrond and black turf in all of which it readily establishes itself and thrives as a ruderal in cultivated lands and along their margins. It is one of the few pasture grasses having a branching habit and is constantly putting forth branchlets of new growth from the nodes, especially when cropped, and thus furnishing fresh supplies of green grass, which is both palatable and of good feeding value. It is well worth establishing in paddocks as grazing for dairy and other animals. It will also make a fair lawn if kept closely cut or cropped.

#### *Lucerne :*

The basaltic red loams with their deep soil, good drainage and adequate supply of lime, are well adapted for the growth of this valuable fodder plant and experimental plantings have proved that it can be successfully established and grown on them without irrigation, though of course with not the same number of cuttings nor luxuriance of growth as when irrigated.

#### *Spineless Cactus :*

Succeeds well on the sandy soils and thrives with a minimum of attention, but makes very slow growth on the red heavy loams unless well cultivated and kept in good tilth.

#### *Potatoes :*

Excellent potatoes are grown in the black turf, which appears to be especially suitable for these tubers.

#### *Sweet Potatoes :*

Do well and produce heavy crops in all soils and afford succulent food for cattle and pigs throughout the winter months besides furnishing the table with a welcome vegetable for six months in the year.

#### *Pumpkins :*

Grow freely and supply a useful dish for the table and a good ration for cattle and pigs.



*Watermelons :*

Grow freely in all soils, the plants yielding large and delicious fruit.

*Mankataans* (pronounced "*Makataans*") :

This is the native name for the Kafir watermelon in general use locally. It comes up spontaneously in lands, grows with the greatest ease and is largely used as a succulent winter food for stock.

*Maranka* ( pronounced "*Maraka*" ) :

A species of *Lagenaria*, closely related to the calabash, several varieties of which are largely grown as a vegetable by natives and frequently come up spontaneously in lands and waste places. They have a delicious flavour and are far superior in taste and delicacy to the vegetable marrow and in addition are very hardy and more easily grown.

As a vegetable they have become very popular with farmers on the Flats, are deserving of a wider market and should be better known.

*Buckwheat.**Linseed.**Rape.**Swedes.*

All of these grow well without irrigation and can be sown after the main crops have been established.

## WINTER CROPS.

Wheat and other winter crops can be successfully grown in the rich alluvial soil of the Nyl Vlei that is subject to inundation during the summer rains, by ploughing and sowing in the moisture-laden soil after the water has receded from it, in the same manner as is practised in farming by the Zaaïdam method in the western districts of the Cape Province..

## FRUIT TREES AND VINES.

The following fruit trees and vines are being grown with success, without irrigation, in asgrond, basaltic red heavy loam, and the red and grey sandy soils, but it is necessary for good results that the soil be deep, well ploughed and kept in a good state of tilth so as to conserve the moisture in the soil.

*Almonds.*—Do well and are very drought resistant. If the improved, soft-shelled varieties are grown, it is absolutely necessary to plant some trees of the common hard-shelled almond with them to ensure pollination, or no crops will be obtained.

*Apples.*—A large number of varieties are suitable, but "*Rome Beauty*" does best of all and is wonderfully well suited to local conditions. There appears to be a great future for its growth on a large scale for export purposes and it is better that growing on a commercial scale should be confined to this variety and its complements "*Missouri Pippin*" and "*Versfeld*," and make them and the Springbok Flats known for their excellence.

To ensure good crops by efficient pollination, after every six rows of "*Rome Beauty*" two rows of either "*Missouri Pippin*" or "*Versfeld*" should be planted. Both of these are well suited to our conditions and flower at the same time as "*Rome Beauty*." Preference should be given to "*Missouri Pippin*" as being in better demand in London where a medium sized apple is preferred to those of larger size like "*Versfelds*."

*Apricots*.—All varieties grow and bear well. The fresh fruit is in little demand and growth on a large scale cannot be recommended unless a canning or jam factory be established in the neighbourhood, or an evaporating plant erected for drying fruit, since sun drying is not practicable in the summer rainfall area.

*Figs*.—All varieties grow well and yield heavy crops.

*Grapes*.—All varieties that are fairly resistant to cryptogamic disease, such as Barbarossa, Crystal, Hanepoot, Hermitage, Madresfield Court and others do well, provided they are sprayed in the winter with Capex or swabbed with the prescribed Sulphate of Iron and Sulphuric Acid mixture, and the usual summer dustings with flowers of Sulphur given.

*Loquats*.—succeed fairly well.

*Medlars*.—are well suited.

*Peaches*.—All Chinese varieties, with the exception of Peento, which flowers too early and gets nipped by frost, do well and bear heavily. The old domestic varieties of Persian origin are a complete failure and will not produce fruit. It has been stated that many of the latter will succeed if they are budded on to Chinese stocks and summer pruned. There is no doubt about Chinese peaches being wonderfully well adapted to local conditions.

*Pears*.—Bon Chretien, Flemish Beauty, Keiffer Hybrid, Le Conte, Wilder and probably others succeed, but all varieties of pears are exceedingly slow in coming in to bearing and it is usually necessary to wait eight years or even longer for a crop. Mr. H. B. Terry states that they come into bearing much earlier if the saffron pear is used as a stock.

*Persimmons*.—All varieties do well. Young trees for the first couple of years after flowering usually shed almost all their young fruit shortly after it has set. The multitude of young fruits formed are far too many for a small tree to carry and the majority should be pulled off.

*Plums*.—All varieties of Japanese plums grow and bear well. The ordinary domestic varieties are a failure and do not bear fruit.

*Quinces*.—All varieties do well.

#### CITRUS FRUITS.

Oranges, naartjes, grape fruit, lemon and pompelmousse can be grown successfully provided they are protected from frost for the first three years. Completely enclosing the young trees with a conical pile of mealie stalks is a quick and very satisfactory method. This is unnecessary in the warmer parts of the Sandveld. It is very important that the ground around them be kept in a good state of tilth in order to retain as much moisture as possible and of great assistance if a good watering can be given them in August. Citrus growing under dry land conditions cannot, however, be recommended on a commercial scale.

#### SUB-TROPICAL FRUITS.

Bananas, guavas, mangoes and pawpaws are successfully grown in warm places in the Sandveld where there is very little frost.

#### CULTURAL NOTES.

Peaches, apricots and plums make very rampant growth under the summer rains and heat and require special treatment, more especially peaches. They should be pruned about the end of January, when growth is less vigorous, for the production of a new set of laterals, more slender and well supplied with fruit buds, to replace the strong, coarse, sappy growth,

not suitable for fruit bearing, produced earlier in the season. Then in the spring, after the fruit has set, these laterals should be cut back so as to leave only two or three fruits at the base of each lateral.

Neither codlin moth, fruit fly, peach aphid, nor fusieladium have so far been introduced. Fruit-eating beetles are troublesome on all but the early varieties of peach, apricot and fig trees, but if hand-picking be taken in hand as soon as the first beetles appear they are easily kept in check. In the Thornveld and everywhere in the neighbourhood of *Acacia* trees (popularly known as *Mimosas*) the fruit-sucking Moth plays great havoc with all soft fruits, such as peaches, apricots, plums, figs and grapes, ripening after the early part of January and eludes all efforts at its control. Scarcely a fruit is allowed to ripen unspoiled and on this account, in Thornveld areas, it is not worth while growing any but early varieties of these fruits, excepting such few choice ones for home consumption as may be worth while protecting by covering over with paper bags ("quarter size" paper bags are purchasable from the manufacturers at about 2s. 6d. for 500), bags made from butter cloth, or even empty tobacco bags. In the case of grapes, which appear to escape attack till later in the season than the other fruits, protection is well worth while and very quickly done. If a little flowers of sulphur be dusted over the berries and shaken into the bottom of the bag before covering up the bunches, beautiful unblemished grapes, free from rust marks, will result, and can be allowed to hang on the vines for a much longer period than if left uncovered.

It seems probable that the fruit-sucking moth is bred out in *Acacia* trees and possibly in virgin country feeds upon the sweet gum exuded from them, seeing that *Acacias* do not produce succulent fruit. In the Sandveld, where a different type of tree prevails, and on bare grassy plains, free from *Acacias*, the fruit moth causes no damage.

#### *Tree Planting and Afforestation.*

The red and grey sandy soils being usually well drained and of great depth, in many cases up to 50 ft. deep, are particularly well adapted for afforestation and trees make surprisingly rapid growth in them. The limiting factors are the practically rainless period extending from May to October and a certain amount of frost, though the latter is not nearly so severe as in the basaltic loam and black turf associations.

Whilst many trees do well in the red basaltic loams and make excellent growth, these loams are not so well adapted for afforestation and with the exception of a few species specially suited, such as *Eucalyptus rostrata* and *Pinus halepensis*, planting on a large commercial scale should be restricted to the red and grey sandy soils.

In the black turf trees are very difficult to establish and tree-planting is not a commercial proposition.

With large citrus and other orchards developing in the vicinity there should be a good demand locally for fruit boxes; the future requirements of the Zebediela Citrus Estate alone being estimated at 1,200,000 boxes per annum. There is also a great demand for them in other parts of the Union, as well as for soft woods suitable for the manufacture of matches and for general purposes. The growing of suitable timber to meet these requirements, such as *Araucarias*, *White Callitris*, *Pines* and *Poplars*, should therefore be a first class investment provided conditions are favourable.

The following trees have been proved to be more or less suited to local conditions as noted against the individual species. There are many others which may probably also be suitable which have not been tried, and further experience will no doubt enable the list to be considerably extended.

*Acacia baileyana* (Bailey's Wattle).

*Acacia decurrens*, var. *dealbata* (Silver Wattle). These are ornamental trees of small to medium size, having silvery foliage and bearing masses of golden yellow capitate flowers. Seasonal conditions are too dry for the majority of the Australian Wattles, which are only suited to the coastal or to the mist belt. The above, however, succeed sufficiently well for ornamental planting around the homestead where they can be watered occasionally, if required.

*Araucaria braziliensis* (Parana Pine). A very valuable softwood, native of Southern Brazil, useful for making matches, fruit boxes and general purposes. Withstands frost, requires a good deep soil and heavy summer rainfall. Grew 50 ft. in twenty years at Mr. A. Selanders' farm (P.O. Glenisla) near Winterton, Natal, from whom seed can be purchased at 9d. a pound. Young trees planted by Captain G. L. Graham, Ypres Halt, promise well and it seems likely to succeed on grey sandy soils of good depth.

*Araucaria Cunninghamii* (Hoop Pine).—One of the very best woods for making matches and particularly valuable for many other purposes, Native of Queensland and New South Wales. Young trees have made remarkable growth on Captain G. L. Graham's farm at Ypres Halt and it promises to do well on grey sandy soils of good depth. It is not hardy against frost. Seeds can be obtained from the Curator of the Durban Botanic Gardens.

*Callitris robusta* (White Callitris). Slow growing tree, reaching a fair size and producing valuable, durable soft-wood. Resembles a cypress and is both drought and termite resisting. Requires a light sandy soil and will not do in the heavy red loams. Trees planted in the Naboomspruit School grounds are doing well and have made fair growth.

*Casuarina cunninghamiana* (Beefwood). A fine large tree yielding hard smooth-grained durable timber suitable for flooring-boards, etc. Requires a deep loose soil and plenty of room and is not recommended for timber plantations. Well suited to local conditions under which it makes fair growth. Its foliage is liable to be eaten by live stock.

*Cedrela toona* (Toon). Fast-growing handsome deciduous tree suited for the moister localities where frost is slight. Yields a valuable cedar-like soft-wood and is recommended by the Forest Department as suitable for plantations. Not yet fully proved on the Flats but three-year-old trees on Tobias Loop, in basaltic loam, are making good growth and promise well.

*Cupressus arizonica* (Arizona Cypress). Handsome, ornamental tree, 30 to 40 ft. in height. Is very adaptable and resistant both to drought and frost. Yields a very compact non-splitting hard timber, suitable for turning and pattern making. Makes an excellent shelter belt for orchards, etc. Have found transplants somewhat difficult to establish in red basaltic loam, but once established the trees do well and grow rapidly.

*Cupressus torulosa* (Himalayan Cypress). Handsome tree with bright green fern-like foliage. Attains a good height and yields a fragrant timber highly valued for furniture. Is also excellent as a wind screen and shelter and when trimmed young is a good hedge plant. Is very hardy and resistant both to drought and frost. Does best in deep, sandy, porous soils, but is growing well at Mosdene in red, basaltic loam, a five-year-old transplant being 15 ft. high.

*Eucalyptus citriodora* (Lemon-scented Gum). Tree of fair size, straight stemmed, with smooth white bark. Branches are sparse and easily snapped by wind. Yields a good timber, similar to spotted gum (*E. maculata*), but is chiefly grown for the oil extracted from its leaves, which is much more valuable than oil from other Eucalypts owing to its pleasant lemon-like fragrance. For this purpose the trees are continually lopped to keep them low and encourage branches and leafy growth. Grows well on shaley soil and stands considerable drought but not much frost. Is doing well at Weltevreden in grey sandy soil.

*Eucalyptus cladocalyx* (Sugar Gum). Straight-growing tree of good height producing valuable durable wood. Stands heat and drought and does not mind heavy soils. Is tender to frost and in the red basaltic loam areas requires to be protected from it during the first winter. Having an abundance of dark green shining foliage and clusters of white flowers, it makes a handsome avenue tree. Is doing well at Mosdene and Klipplaats.

*Eucalyptus hemiphloia*, var. *albens* (Grey Box). A rather small tree, very resistant to drought, stands a fair amount of frost, grows well in clay soil and Griffith reports that it will even survive on an ironstone ridge. Its wood is considered in Australia to be of great value where durability and toughness is required. Is doing well in red, basaltic loam at Mosdene but is very much slower growing than any other Eucalypts planted.

*Eucalyptus maculata* (Spotted Gum). Fine, straight-growing tree producing the well known hard-wood largely imported for wagon building, etc. Is too tender to frost for the red, basaltic loam areas, but is fairly hardy to drought and does exceedingly well in the deep, grey sandy soils where there is little frost and is well suited for planting on a large scale. Where the frost is not severe it has proved wherever grown to be the best gum for local conditions.

*Eucalyptus Maidenii* (Maiden's Gum). A very fast-growing large tree resembling the common blue gum (*E. globulus*) but having timber of better quality. It is somewhat more hardy to frost and drought and even of faster, straighter growth. Transplants planted at Mosdene four years ago in red, basaltic loam, spaced 6 ft by 6 ft., grew 25 ft. in two years, but have not done well during the heavy drought of the present season and evidently require moister conditions than *E. rostrata* which has not suffered. On the other hand trees in grey sandy soil on Weltevreden have come through very well and are continuing to make good growth.

Many of the transplants obtained had been hybridised with pollen from *E. viminalis* on an adjoining block and show every gradation in foliage from that of almost pure *E. Maidenii* to almost pure *E. viminalis*, whilst all retain the stout, sturdy growth of the former. These hybrids seem fully as sturdy and even faster growing than the pure *E. Maidenii*.

*Eucalyptus melliodora* (Yellow Box). One of the hardiest trees against frost and drought, of medium size, more leafy than most gums and excellent for shelter belts. Wood tough and durable, but is not as straight-growing as many species. A moderately fast grower, doing well at Mosdene in basaltic loam.

*Eucalyptus microtheca* (The Coolbahi Gum). Small tree requiring a loose, sandy soil. Stands extremes of drought and heat, being a native

of the arid inland parts of Western Australia. Will not stand heavy frost. Is a very slow grower and produces very strong wood. Does very well under local conditions.

*Eucalyptus polyanthemus* (Red Box). Medium size tree, hardy to drought and frost, a moderately fast grower and well suited for shelter belts. Yields tough, heavy wood. Doing very well in red, basaltic loam at Mosdene.

*Eucalyptus resinifera* (Forest Mahogany). Said to be one of the best Eucalypts for warm, moist regions where the frost is not severe. Is straight-growing and produces timber closely resembling jarrah wood. Appears to be well suited to local, deep, grey sandy soils. Next to *E. maculata*, it is doing the best of all the gums at Weltevreden and has not suffered at all during the recent severe drought.

*Eucalyptus rostrata* (Red Gum). Is a straight stemmed fast grower, said to attain a height of 150 to 200 ft., extremely hardy under local conditions and can be thoroughly relied upon. Does well both in the red basaltic loam and in the red and grey sandy soils and stands much drought, heat and frost. Its wood is a light red, paler in colour than in Australia, and is reported to be extremely durable both above and below ground, and when carefully seasoned has an excellent reputation for wagon work, flooring-boards, doors, etc. Can be recommended for planting on a large scale.

*Eucalyptus saligna* (The Saligna Gum). An extremely fast growing straight tree attaining a large size. Requires a deep, loose soil with plenty of moisture and little frost. Yields a durable wood useful for building and other purposes provided it is seasoned in a proper manner, otherwise it is liable to split badly. Attempts have been made to use it for fruit boxes, but their quality is very inferior and quite unfit for export fruit. It is well suited locally to the deep sandy soils and in a large plantation near Nylstroom some hundreds of thousands of these trees are reported to be wonderfully healthy, with scarcely a blank and three-year-old trees, 40 ft. high. They are also doing well at Weltevreden. They are quite unsuited to the red basaltic loam area and a large percentage of two year-old-trees 20 ft. high, succumbed at Mosdene in basaltic loam from drought and unsuitable conditions.

*Eucalyptus sideroxylon* (Red Ironbark). Very hardy, stands much frost and drought, will succeed in a wide variety of soils and has been known to do well in shallow soil resting on a shale subsoil. Is a moderately fast grower of fair size and yields a very hard and durable wood of a deep red colour, equal to jarrah. Is doing well in red basaltic loam on Mosdene.

*Eucalyptus viminalis* (Viminalis or Willow Gum). Very frost-hardy and quick-growing and thrives well in the moister districts of the High Veld. Is killed by drought in drier districts. Is not suited to this area and its timber is of very poor quality. Heat as well as drought appears to affect it adversely and trees planted at Mosdene in red basaltic loam are a failure.

*Gravillea robusta* (Silky Oak). Handsome tree, growing 50 to 60 feet high, with beautiful fern-like foliage and masses of orange-yellow flowers. Yields a soft handsome wood with a silver grain. Does best in a deep loose soil, in warm and fairly moist localities. Is particularly well suited to the local sandy soils and stands a considerable amount of drought. Succeeds fairly well in red basaltic loam, but being somewhat tender to frost in the latter area requires to be protected from it whilst young.

- Jacaranda mimosaeifolia* (Jacaranda). A very ornamental tree of medium size, with handsome pinnate leaves and abundant sky-blue flowers. Hardy to drought and heat but tender to frost. Is semi-deciduous. To prevent seraggy growth young trees should be heavily pruned in the winter, after formation of a straight stem. Does well both in sandy soils and basaltic loam, but young trees must be protected from frost.
- Melia azedarach* (Syringa or Pride of India). A very ornamental shade and avenue tree of medium size having dark glossy green pinnate leaves which assume beautiful tints in the autumn, whilst in the early spring it bears masses of sweetly scented lilac flowers. It is deciduous and young trees should be pruned to shape in the winter. It is very hardy against frost and drought, thrives in all soils and is one of the very few that do well in the black turf. It makes fairly rapid growth, particularly in deep, loose soils, and can be struck from cuttings. The wood is of good quality, fairly soft and easy to work and would probably do for fruit boxes.
- Morus alba* (White Mulberry). The silkworm mulberry. Large deciduous shrub or small tree. Does not reach timber size and is only suitable for hedges and break winds. Extremely rapid grower, well suited to the local lighter soils and can be struck from cuttings.
- Pinus canariensis* (Canary Island Pine). Large tree growing to 60 feet or more, hardy to drought, but not to severe frost, and does well in summer rainfall areas. Grows fairly fast, seems well suited to the deep local sandy soils and is making good growth at Weltevreden. Will not thrive on basaltic loam or other heavy soils. Produces an excellent timber after the nature of red deal.
- Pinus halepensis* (Aleppo Pine). Large tree, growing to 60 feet. Rather slow growing but very hardy to heat, drought and frost. It requires a soil rich in lime and is well adapted to the local red basaltic loams. It is doing exceedingly well at Mosdene, where, after the first two years during which growth was slow, it has made fairly rapid growth, attaining a height of 15 feet five years after setting out the transplants. It makes a first class shelter belt and can also be cut and trimmed and grown as a high hedge. The South African grown wood is white and fine-grained, closely resembling "white pine" and is specially valuable. For timber purposes it should be planted rather closely to prevent knots, as it otherwise produces rather heavy side branches.
- Pinus insignis* (Insignis Pine). The most rapid growing of all the pines, and attains a height of 80 feet and over. It is very hardy against frost but not against drought. Is most at home in the coastal districts having a winter rainfall, but thrives equally well inland in moist, deep, sandy, porous soils. Is not suited for the heavier loams. The wood is rather brittle, producing ordinary deal for building purposes and is excellent for fruit boxes. Is doing well in deep grey sandy soil at Weltevreden.
- Pinus longifolia* (Chir Pine). Large tree from the lower Himalayas where it attains a height of 100 feet. It thrives best on mountain sides or in deep, porous soils and will stand moderate frosts, a fair amount of drought and a little lime in the soil. Well established trees are doing particularly well near Pietersburg and local deep sandy soils seem well suited for it. 4-5 year old trees have made excellent growth at Weltevreden in grey sandy loam and are amongst the most promising of the pines tried. At Naboomspruit Railway Station there are some old established trees doing fairly well, although in somewhat unsuitable soil.

*Populus deltoidea*, var. *missouriensis* (True Carolina Poplar). A very fast-growing large deciduous tree yielding one of the best woods for the manufacture of matches. Requires a good deep soil which is both well watered and well drained and is well suited for a tropical climate. It is thought that this valuable poplar will probably do well in the rich alluvial soils of the Nyl Vlei, for which it is considered the most suitable species, but since poplar growing has not previously been tried on open plains, arrangements have been made with the Lion Match Factory for some experimental plantings in the Vlei near Naboomspruit, to be followed if successful by plantings on a larger scale.

Poplars as a general rule are grown in alluvial soil on river banks sheltered by hills, as at Middelfontein Mission Station, where the grey poplar (*P. canescens*) has long been established.

*Salix caprea* (Goat Willow). *Salix purpurea* (Purple Osier). *Salix viminalis* (Osier). Osiers yielding rods used for basket making. The Nyl Vlei is admirably adapted for their growth.

*Schinus molle* (Pepper Tree). A medium size shade tree with drooping branchlets, timber of no value. Apt to be rather scraggy unless grown under good conditions. Does well in all soils if transplants are protected from frost.

#### *Native Timber Trees.*

An account of the numerous native trees yielding valuable timber has been published as a separate memoir.

#### *Dairying.*

With thickly grassed lands, rich in grasses of high feeding value, in which cattle can find grazing all the year round and obtain shelter and shade from the many scattered tree clumps, the Flats, and particularly the Nyl Vlei and Thomboti association, form an ideal country for dairying, which must in time form an important industry, complementary to the growing of maize and other crops. Grazing must of course be supplemented by feeding and there is no other place in the Union where this can be more cheaply or better provided. Heavy yields of green maize plants for silage and various other grass crops for hay can be readily grown after the main agricultural crops have been established, and these combined with peanut hay, pumpkins, mankateans, rape, swedes and spineless cactus, all easily grown by the farmer himself, without irrigation, provide a succulent and varied diet throughout the winter and dry season, and with proper attention dairy animals can be maintained in the pink of condition throughout the year.

The country is perfectly healthy for cattle: ticks and tick diseases are the only trouble, and by regular dipping, which has been made compulsory by proclamation, these are easily kept in check.

In spite of this, being all new country, dairying has so far made very little headway. At present, the young Settlers have all their capital and energies absorbed in the costly and hard work of converting the open veld into developed farms by clearing and bringing the virgin soil under cultivation, making provision for water in a land destitute of streams or ponds, and by the erection of the various buildings and other requirements for the homestead. This is a matter of years and dairying must wait till time and labour can be given to it and till sufficient money has been saved to meet some of the heavy expenses incurred in development and leave enough over to purchase and house a good dairy bull and some cows and to construct a silo.



### *Pig Breeding.*

My remarks under dairying are to a large extent also applicable to pig breeding, which fits in well with it and maize growing and there is profitable scope for the carrying on of these industries side by side on a large scale. With skim milk as a by-product of dairying, together with home grown maize, a well balanced and very cheap ration is obtained on which pigs thrive, particularly if supplemented with dry land lucerne or monkey nut hay and sweet potatoes, pumpkins or other succulent foods, all of which can be grown on the farm.

Pig breeding does not require so much capital as dairying and is already being carried on locally, on a fair scale, with considerable success. The Nyl Vlei, where pigs find a large supply of appetising food amongst the native vegetation, is particularly suitable.

### *Poultry Farming.*

By co-operation and the formation of an "egg-circle" a very large industry could be built up in poultry farming. Poultry thrive well, are very free from disease and many farmers engage in the business in a small way.

### *Horses and Mules.*

Horse breeding is for the present out of the question owing to the prevalence of horse sickness. There is considerable mortality amongst horses from this disease and, to a smaller extent, amongst mules, unless they are either salted or have been immunised. Neither horses nor mules should be brought into the district unless they have been thus protected. Donkeys are immune.

### *Sheep and Goats.*

Cape sheep and half-bred Persians, and boer goats, are farmed to a certain extent, but without much profit, owing to the mortality from heart-water, conveyed by the bont tick. This mortality will no doubt be steadily reduced by dipping as time goes on and the indications are that eventually sheep will do well on the Flats.

## RAW MATERIALS FOR INDUSTRIES.

### *Tanning Plants.*

The tubers of *Jatropha Zeyheri* and *Elephantorrhiza Burchellii* (Elands Boontjes) the pods of *Acacia Benthami* (Lekkerruik peul) and the bark of *Acacia karroo* (Sweet Thorn) yield good tanning material, which is frequently used by farmers to tan skins and make leather for their own use. Of these, *Jatropha Zeyheri*, the large tubers of which are abundant, is considered the best and I have seen good shoes made from leather tanned with this material.

### *Vegetable Dyes and Ink.*

Native species of *Indigofera* are abundant and the Indigo plant, originally introduced into India from South Africa, would no doubt thrive.

The large tubers of *Elephantorrhiza Burchellii* (Elandsboontjes) which is abundant, make an excellent khaki-colour dye.

The pods of *Acacia Benthami* (Lekker Ruik Peul) are used for making ink.

### *Chicory or Coffee Substitute.*

The roots of *Boscia albitrunca*, known as "motlope," are stamped, dried and roasted by natives for coffee, which is also greatly favoured by

some of the old resident Dutch farmers. Others again find it too strong and use it as a chicory substitute. It is also eaten by natives mixed with their mealie porridge and even by itself, raw. Some of the country traders regularly keep it in stock for sale.

#### *Fibre Plants.*

The stems of *Hibiscus Cannabinus*, *Triumfetta trichocarpa* and *Sans-sevieria* spp. and the bark of *Securidaca longipedunculata* all yield fibres of value. *Hibiscus Cannabinus*, which grows abundantly and yields fibre of great length, is used for the manufacture of grain bags and wool packs, and might form the basis of a considerable industry.

#### *Paper Making Material.*

The following grasses yield material suitable for paper-making, but the absence of water militates against their preparation for paper-making, viz.: *Hyparrhenia Ruprechtii*, *Schizachyrium semiberbe*, *Cymbopogon excavatus*, *Tristachya pedicellata* and *Setima Galpinii*.

#### *Oil Seeds.*

The seeds of *Ximenia americana* (Zuur pruim) are of fair size, have a very thin skin, are easily crushed and yield over 40 per cent. of oil, regarding which there are good prospects of its being of considerable commercial value provided it can be supplied in sufficient quantity to make it worth while for manufacturers to deal with it. *Ximenia americana*, which has an edible fruit, grows in fair quantity in some parts of the sandveld and bears heavy crops and could easily be brought under cultivation.

The seeds of *Pappea fulva* (Olie pitten) also yield a large percentage of oil.

#### *Gums.*

*Gambretum erythrophyllum* (Vaderlands Wilgeboom) and *C. Zeyheri* (Raashos) are reported to yield a valuable gum.

#### *Medicinal Plants.*

There is a small demand from S.A. Pharmacists for the roots of *Sans-sevieria thyrsiflora*, which grows in the Thomboti association, for the manufacture of medicinal preparations.



UNION OF SOUTH AFRICA.

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Botanical Survey of South Africa

MEMOIR No. 13

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THE VEGETATION  
OF THE  
RIVERSDALE AREA  
CAPE PROVINCE

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*By J. MUIR, M.D., D.Sc.*

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ISSUED BY THE ADVISORY COMMITTEE FOR THE BOTANICAL  
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DIVISION OF BOTANY, HORTICULTURE, AND

ENTOMOLOGY,

PRETORIA,

6th November, 1928.

Sir, -

I have the honour to transmit herewith for publication the manuscript of a paper by Dr. John Muir, M.D., D.Sc., entitled

“THE VEGETATION OF THE RIVERSDALE AREA,”

and I have to recommend that the paper be printed as No. 13 of “The Memoirs of the Botanical Survey of South Africa.”

The account of the vegetation of the Riversdale area is the result of work done on the flora by Dr. Muir during the past 20 years, and is another link in the chain of information we are forging about our native vegetation. Dr. Muir, besides being a most assiduous collector, is a keen observer, and the facts he has put together must serve as a pattern for future work on the same lines. It is hoped that in the near future a full list of the plants occurring in this area will be published by the Survey.

The State is under a deep debt of thanks to Dr. Muir for presenting his collection to the National Herbarium, Pretoria, and the majority of the species mentioned in the paper will be found in this collection.

I have the honour to be,

Sir,

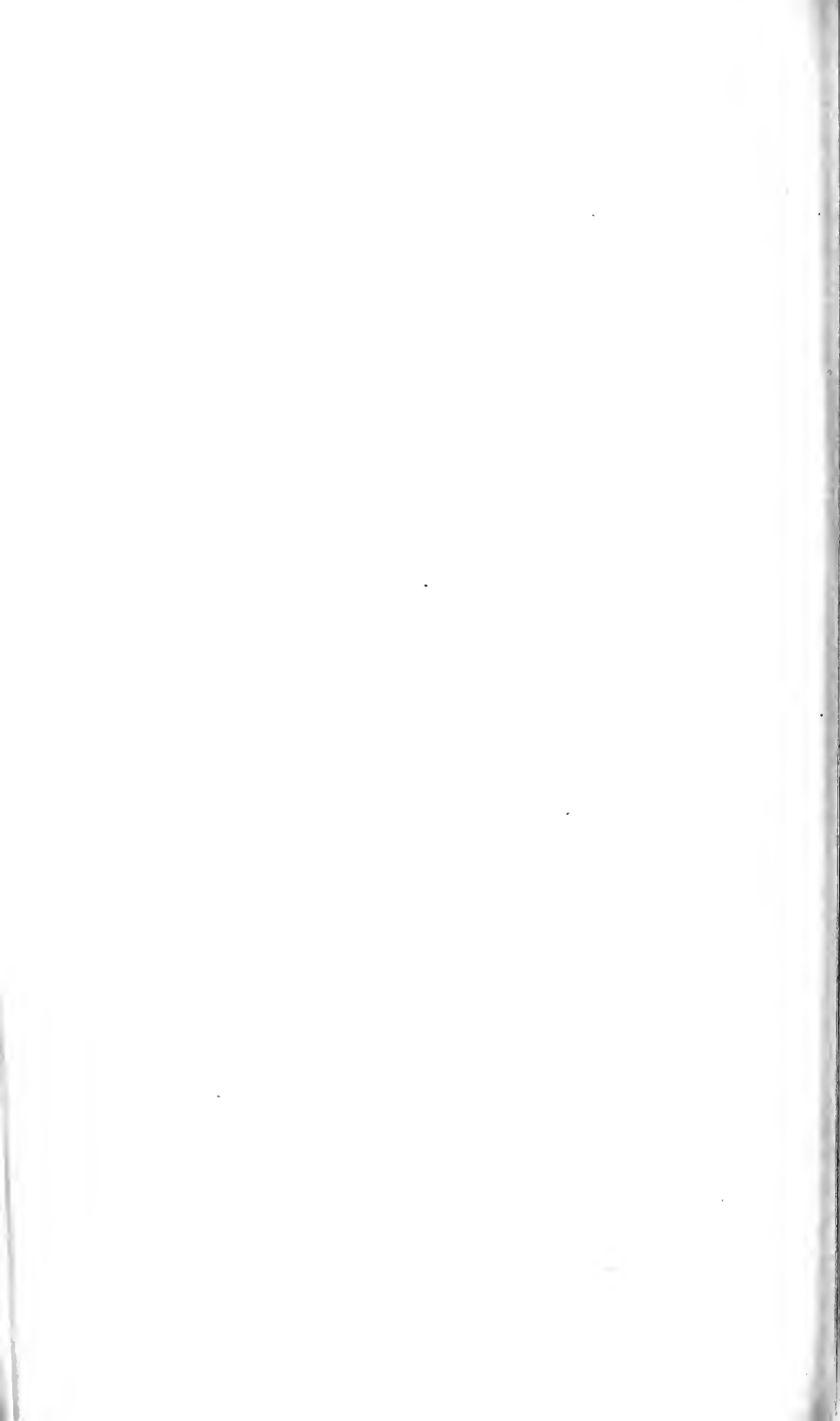
Your obedient Servant,

I. B. POLE EVANS,

Director, Botanical Survey of South Africa.

To

*The Secretary for Agriculture, Pretoria.*





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Plants Common to Base and Summits.

##### (d) *Northern Slopes and Base*.

Note on the Leaves of *Proteaceae*.

#### 3. The Langebergen Forest and Stream Vegetation.

#### 4. The Aasvogelberg and Ridges.

### IV. THE VEGETATION OF THE KLEIN KAROO.

#### 1. Plains.

#### 2. Hills. “ Quartz Fields ” and Mimetic Plants.

#### 3. River banks and watercourses.

### V. FRESH WATER AQUATIC AND MARSH VEGETATION.

#### PARASITES.

#### SYSTEMATIC ELEMENTS OF THE FLORA.

##### Analysis.

Genera arranged according to size.

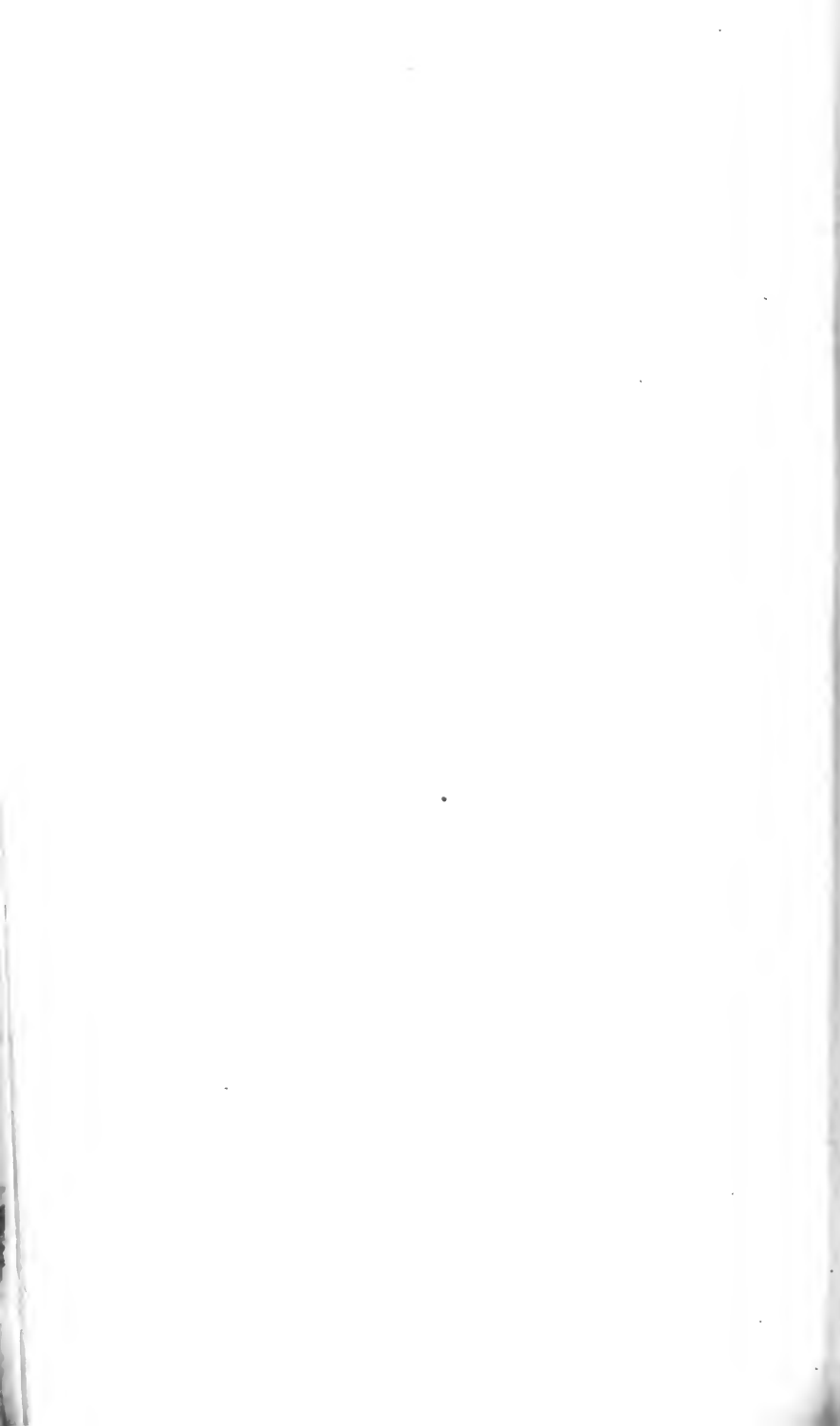
#### DISTRIBUTION OF FAMILIES, WITH SPECIAL REFERENCE TO RIVERSDALE.

#### LIST OF FAMILIES AND GENERA.

#### ABBREVIATIONS.

R.V.	Renosterveld.
U.S.	Uitenhage Series.
W.S.	Witteberg Series.
T.M.S.	Table Mountain Series.
B.S.	Bokkeveld Series.
L.B.	Langebergen. The southern aspect is to be understood unless otherwise stated.
O.F.S.	Orange Free State.
†	indicates that the species is not native.
Dist.	distribution.

NOTE.—The names “ Swellendam ” and “ George ” as used in the early volumes of the Flora Capensis have meanings different from the modern ones. “ Gouritz River, Swellendam, ” is now Riversdale: “ Gouritz River, George, ” is now Mossel Bay. Errors have arisen in the later volumes through this not being kept in mind, the delimitation of these districts having been made anew in 1848.







## INTRODUCTION.

The vegetation of Riversdale is here described as it appeared between the years 1912 and 1925. It is based on my own collections of plants, and to a smaller extent on the lists given in the *Flora Capensis*. Many species discovered by Thunberg and Burchell have not been found by more recent collectors, and have possibly in some instances been destroyed by fire. In the course of another century more will have disappeared, and considerable changes occurred in the appearance of the vegetation as a whole. The Aloe scrub is being cleared away, and the macchia of the Langebergen is undergoing rapid modifications by the hand of man. Many plants were, however, found by the writer that were not seen by the early collectors.

A set of my plants, almost complete, has been placed in the Bolus Herbarium, University of Capetown, and many are in the National Herbarium at Pretoria, the South African Museum at Capetown, and the Albany Museum at Grahamstown.

The work was first suggested by the late Professor H. H. W. Pearson, and would never have been attempted but for the practical interest of a few friends. All plants have been determined at the Herbaria mentioned, and the larger families have been examined by specialists. I am under deep obligation to Mrs. Bolus for help with *Aizoaceae* and *Ericaceae*, and to her and to the staff of the Bolus Herbarium grateful thanks are tendered. Professor R. H. Compton was always willing to give me invaluable advice in cases of difficulty, and the many sided assistance afforded me by Dr. R. Marloth of Capetown will not readily be forgotten. To Professor S. Schönland I am indebted for verifying *Crassulaceae* and *Cyperaceae*. Much inspiration has been derived from the ecological writings of Professor J. W. Bews of Maritzburg, and these have been used as models wherever applicable. Dr. T. R. Sim has named *Bryophyta* for me, and Mr. N. E. Brown, A.L.S. of Kew many *Aizoaceae*.

Finally I owe an incalculable debt to my wife for preserving specimens at a time when I was fully occupied by the cares of professional practice. She is commemorated in *Protea Susannae*, *Thesium Susannae* and *Euphorbia Susannae*.

Leeuwarden,

Riversdale, South Africa,

31 March, 1925.





## PREVIOUS COLLECTORS.

The earliest travellers to make extensive collections of plants in the Riversdale Division were C. P. Thunberg, F. Masson and Johan Andreas Auge between 1772 and 1774, the first named traversing the district on three occasions. Andreas Sparrman followed in 1775, and Lieutenant Paterson in 1779. François le Vaillant passed in 1781, but he devoted more attention to birds. Heinrich Lichtenstein came between 1803 and 1806, and gave an account of his visit to Auge, who was then nearly one hundred years old, on the farm Rotterdam, near Swellendam.\* W. J. Burchell in 1814, travelling from East to West, collected extensively about Zoetmelks River, Garcia's Pass and Spiegel River. He had a station at Klein Vet River (often called locally the Naroo River) about one mile from Riversdale. His "mountain station" was at the southern entrance to Garcia's Pass on the Great Vet River. "Valley River's Poort" was a name given by him to the present Garcia's Pass. The waterfall, which he so often mentioned, is to-day crossed by the road from Riversdale to Ladismith, and is often called Kristal Kloof. In 1814 there was only a bridle-path, and waggons going to the Klein Karoo had to make a detour by Plattekloof and the Gysmanshoek Pass.

James Niven, gardener to George Hibbert of the English East India Company, was in South Africa between 1798 and 1803, and collected many rare *Proteaceae* in the Langebergen; and about the same time Dr. William Roxburgh, later a physician on the Coromandel Coast visited this region, his collections being finally acquired by the Herbarium De Lessert in Paris. Dr. George Thom of the London Missionary Society, later Dutch Reformed minister at Caledon and Tulbagh, who came to South Africa in 1812, is often quoted in the "Flora Capensis" for plants which he obtained in Riversdale. He died in 1842.

In 1829 J. F. Drège visited the Aasvogelberg, the Gouritz River Mouth and other places in this neighbourhood. He was followed by Mund and Maire, Gill, Bunbury in 1838, Krauss about 1840, and by Pappe who died in Capetown in 1862. Ecklon and Zeyher journeyed through Cogmans Kloof near Montagu, thence through the Klein Karoo and encamped by the Gouritz River.

In more recent times Dr. R. Schlechter made his headquarters at Riversdale for some time and is still remembered here. Dr. H. H. Bolus, Mr. E. E. Galpin, and Dr. E. P. Phillips made subsequent collections. Comrath Rust was a storekeeper at the farm Tygerfontein, near Albertinia, and died in German South West Africa in 1922.

## BOUNDARIES OF THE AREA.

The area under consideration is bounded on the south by the Indian Ocean from the Gouritz River to the Duivenhocks River; on the west from south to north by the Duivenhocks River, and a line over the Langebergen Range into the Klein Karoo dividing it from the Swellendam Division; on the north by a line through the Klein Karoo more or less parallel to the Langebergen Range dividing it from the Ladismith Division; and on the east from north to south

\* See "Gedenktekens van Swellendam," in "Die Huisgenoot," Capetown, October, 1927, by the writer.

by the Gamka River and the Gouritz River. It includes on the west the mountain of Grootvaders Bosch, but not the famous forest of that name. This area is, roughly speaking, square, extending about forty-four miles inland and about the same from west to east. It is 1,711 square miles in extent. In addition to the above, however, the eastern shore of the Gouritz River, and the great bastion of the Langebergen known as the Vryers Berg have been admitted, although slightly beyond the limits of the Division. This mountain is the prolongation of the Riversdale range and is separated from its eastward extension by Cloete's Pass. These limits are artificial except on the south, and not truly phyto-geographical.

The account given of the vegetation of Riversdale holds good largely for the Divisions of Swellendam and Mossel Bay as well, and to some extent for the Division of Ladismith and a large portion of the Klein Karoo.

### NATURAL DIVISIONS OF THE AREA.

The Riversdale area is divisible into four portions which differ geologically and botanically, and have long been distinguished by popular names:—

1. The Strandveld, known popularly as the "Duine."
2. The Renosterveld, known as the "Hardeveld" or "Mid-delveld."
3. The Langebergen, usually termed the "Langeberg."
4. The Klein Karoo, usually called simply the "Karoo."

The two first portions lie south of the Langebergen, and form together the first of the four great plateaux into which South Africa can be divided. The Klein Karoo lies north of the Langebergen and forms the second plateau. They are separated by the escarpment of the Langebergen, which constitutes an important factor in the climatology.

There are no lakes, nor any large natural areas of water. There are no vleis nor lagoons near the coast. Some small salt-pans are found at Zoutpan in the Strandveld and will be considered later. Extensive marshes exist at Oakdale near Riversdale adjoining the Vet Rivier; and there are others about the sources of rivers and streams near the Langebergen at Wyders Rivier, Valsch Rivier, Novo, Corente Rivier and Plattekloof.

#### 1. The Strandveld.

##### *Topography.*

This is known locally as the "Duine" (cf. English "dunes"), and occasionally the "Dowus." The latter term should be avoided, as it has no resemblance to the areas known in other countries by that name. It is the coast-belt, and extends for about 44 miles from the Gouritz River to the Duivenhoeks River. From south to north it varies in width from 8 to 20 miles. The coast line is low lying, without cliffs, and the land usually slopes gradually to the sea. There are beaches of shingle here and there at Gouritz River Mouth, Yzervarkfontein and a few other places, and the shore is fringed with low rocks in many localities. The mainland, where it shelves down

to the beach, is, however, almost invariably sandy. The mobile dunes rise in terraces from the sea to a height of 300 feet in places, being usually although not always higher where the fore-shore is sandy. At Noordkappers Hoek and at Plattebosch the sand dunes are distinctly reddish, whereas elsewhere and more usually they are lighter in colour. Samples of both of these types have been sent by the writer for geological research. These reddish areas, where fixed, are considered by farmers more valuable than the lighter areas, and carry a more luxuriant vegetation. The landward side of the foremost dunes may be mobile like the seaward side and summit, but the tendency is often to be more or less fixed. At the base there is usually a valley clothed with dense bush or dune scrub, and definitely fixed. The remaining portion of the Strandveld consists of extensive areas of hills and valleys of fixed sand, intersected by rocky ridges and outcrops of dune limestone. There are few roads, and travel is in places only possible on horseback or by ox waggon, which traffic tends to set the fixed dunes moving. Veld burning, assisted by the action of wind afterwards, leads to the formation of occasional bare areas. Nearly everywhere, however, on the sandy flats and slopes, as well as on the rocky ridges, there is a more or less complete covering of vegetation most of the shrubs of which are evergreen. This forms a marked contrast with the bare mobile dunes at the coast, and the Renosterveld to the north. The northern boundary is a natural one. It begins on the Duivenhoeks River at Melkhoutkraal, and runs past the farms Jakhalsfontein, Barend Saayman's Eere Dood, Zoutpan, Tygerfontein, Albertinia, and thence south of the Aasvogelberg, by Welgevonden to Gouritz River. The village of Albertinia lies just within the Duine, and except at the sea, river banks, and the alluvial area at Elberts Kraal it is sparsely settled. The altitude ranges from sea level to 660 feet, the latter being the height of the government beacons at Rietvlei and Droogevlakte above sea-level.

Contrary to what might be expected it is a pleasant, beautiful, fertile region. The abundance of flowering shrubs and entomophilous herbs makes it one of the chief honey-producing districts in South Africa. Rye, oats, barley but not wheat have been cultivated largely in recent years in the fixed sand; and milk, butter and vegetables are obtainable in the Strandveld when unobtainable in other parts of the Riversdale Division.

The Gouritz, Kafir Kuils and Duivenhoeks Rivers, in order named from east to west, cut the Duine deeply from north to south at right angles to the sea-coast.

#### *Geology and Soil Conditions.*

The Strandveld belongs to the Coast Belt and the remainder of the Riversdale Division to the Folded Belt. The former is comprised of superficial deposits, recent limestones, recent blown sands and sand deposits. This dune limestone is of the special type found in similar sandy coast regions, and is derived from the hardened dunes. It is described in detail by Drs. Rogers and du Toit. (An Introduction to the Geology of Cape Colony, London, 2nd Ed.) It becomes extremely hard and forms innumerable hills and ridges. On the farm Victoria Dale a borehole 272 feet deep showed limestone throughout. The blown sand, however, conceals the solid geology of the flats, and

the sandy covering is of course much thinner there than on the coast. Under this sand at many places on the flats, limestone is found at a depth of one or two feet, and in the western portion clay lies at a depth of two to three feet. Roads are made by covering the sand first with *Thamnochortus insignis* or other available *Restionaceae* growing near, and secondly with a top layer of clay, limestone or gravel, the result being satisfactory. The limestone, although in places impure from the admixture of sand, is very often pure enough to be burnt, and forms the source of the lime used for building purposes in Riversdale and district, including high class government contracts. It is burnt in pits or in heaps on a firewood platform, the wood being supplied by the rare *Proteaceae* close at hand. The lime has therefore not been leached out, and this question of degree of purity becomes important when the question of calcicole *Restionaceae* and *Proteaceae* is considered later. The channels of the principal rivers have cut through the sand and limestone down to the underlying Bokkeveld Beds which are there exposed, and on the sides of these valleys the sand is thin or absent. On a few places on the extreme coast, notably at Cape Barracouta, near Still Bay, near Rietvlei, and from Yzermark Point on Buffelshoek eastwards to Gouritz River Mouth the Table Mountain Series (sandstone and quartzites) appears as a narrow strip.

There is a large area of alluvium at Elberts Kraal on the Gouritz River.

Near Zoutpan there are four salt-pans which have been produced primarily by wind erosion. The largest measures 300 by 150 yards, is somewhat elliptical in shape, and when full of water is waist-deep. It produces in good years 300,000 pounds weight of salt suitable either for the table or for cattle. The three smaller ones are more or less circular in outline and knee-deep, one being 75 by 50 yards, and another 100 by 75 yards. They are all exposed fully to the sun, and evaporation is the chief factor producing shallowing, which proceeds until they become quite dry, when salt is deposited. There are no springs present in the pans, and no streams enter or leave them.

On the northern boundary of the eastern part of the Strandveld stands the Aasvogelberg belonging to the Table Mountain Series, 1,611 feet high, its southern slopes running down to the Strandveld, and its northern side to the Bokkeveld Series. It is prolonged westwards as a ridge of hills which is largely within the Strandveld, and 1,175 feet high at the government beacon near Albertinia. The mountain and ridge are steeper on the southern than on the northern side and in a few places on the former are precipitous.

Water from wells in the tertiary limestone at Kanka and elsewhere is usually brackish, but that which issues from between it and the shales is excellent.

#### *Climate of the Strandveld.*

Much of the vegetation of the Riversdale Division is of the sclerophyllous type. The determining factors of this are climatic, and all particulars of meteorology which could be obtained have therefore been recorded.

(1) *Rainfall and Humidity*.—Full and reliable figures are available for Mossel Bay on the coast, 34.11 Lat. S. and 22.09 Long. E.: for Vogel Vlei on the eastern border of the Division 34.13 Lat. S. and 21.49 Long. E., six miles from the coast; and over a short period for Melkhoutfontein on the Kafir Kuils River,  $2\frac{1}{2}$  miles from the coast on the limestone hills.

The average mean rainfall in inches, the percentage of summer and winter rainfall, and the average number of days in the year on which rain fell, are shown in Table I.

TABLE I.

	Inches.	Wet days.	Summer, % age.	Winter, % age.
Mossel Bay*.....	17.31	90	47	53
Vogel Vlei*.....	17.40	40	50	50
Melkhoutfontein†.....	20.88	75	—	—

\* Guide to Botanical Survey Work, Pretoria, 1922.

† Rep. Meteor. Comm. 1901-3, Capetown.

The observations at Mossel Bay were from 1877-1915; for Vogel Vlei from 1900-1915. Statistics for Melkhoutfontein were from 1901-1903, the total rainfall being 17.40, 30.96 and 14.29 inches, respectively, and the wet days 73, 72 and 80. But the year 1902 was exceptionally wet, the total rainfall at Mossel Bay and Vogel Vlei being 25.62 and 23.48, respectively. Such figures, however, have a value by showing extremes, and are all that are obtainable for Melkhoutfontein.

The distribution of the rainfall over the year is shown in the following tables:—

TABLE II.

*Mossel Bay: Annual and Monthly Rainfall, 1893-1902.*

Year.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1893	1.20	0.47	1.91	0.62	1.86	0.42	0.47	0.37	2.48	2.28	3.44	0.73	16.25
1894	1.36	0.38	2.26	2.48	0.93	0.46	0.67	0.78	0.58	1.19	2.10	0.62	13.81
1895	2.33	0.46	0.18	1.14	0.61	0.91	0.40	0.01	1.79	1.08	0.91	2.18	13.00
1896	0.69	0.94	1.14	3.79	1.12	1.46	0.61	2.40	1.09	0.95	1.35	1.33	16.87
1897	0.55	0.75	1.02	0.63	2.32	0.98	0.60	1.09	2.01	2.15	1.26	0.62	13.98
1898	5.90	2.68	1.79	2.26	1.55	0.93	2.86	1.17	2.01	2.44	1.30	2.43	27.32
1899	0.26	1.11	2.35	1.30	1.85	1.01	0.50	0.53	0.56	1.29	0.27	2.11	13.11
1900	2.29	1.11	2.04	6.24	1.20	0.85	0.52	1.98	0.56	1.44	0.37	3.01	21.61
1901	1.14	4.76	0.90	0.82	1.11	1.06	0.55	1.43	3.57	0.76	1.79	0.21	18.10
1902	0.53	4.65	3.95	0.22	0.97	2.03	1.25	3.48	3.25	2.09	0.96	2.24	25.62

TABLE III.  
*Vogel Vlei.*

Year.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1900	—	—	—	—	0.60	0.70	0.37	2.90	0.05	1.24	0.34	4.62	—
1901	4.69	4.64	1.46	0.49	1.53	1.42	0.54	0.76	3.72	0.20	1.32	0.00	20.77
1902	0.50	4.30	3.33	0.03	1.75	1.67	0.63	4.07	3.43	1.56	0.28	1.93	23.48
1903	0.00	0.33	0.00	1.16	0.00	1.38	0.71	1.11	0.17	3.12	6.58	0.00	14.56

TABLE IV.  
*Melkhoutfontein.*

Year.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1901	1.98	3.19	0.83	0.64	1.47	1.58	0.52	0.94	3.06	0.96	2.12	0.11	17.40
1902	0.87	5.68	4.05	0.34	1.38	2.67	1.08	2.03	8.70	2.20	0.57	1.39	30.96
1903	0.27	0.42	0.75	0.97	0.26	1.67	0.91	0.84	0.23	2.31	6.21	0.08	14.92

The means for each month (1900-1902) of the figures for Relative Humidity taken at Mossel Bay were:—

TABLE V.

January.....	66.6	May.....	77.0	September.....	79.3
February.....	78.0	June.....	75.6	October.....	72.6
March.....	77.3	July.....	73.3	November.....	69.3
April.....	81.3	August.....	79.3	December.....	77.0

Saturation is 100. The mean monthly rainfall during the same period has been shown in previous tables.

(2) *Temperatures of the Strandveld.*—At Mossel Bay for 1900-2 the average mean maximum was 69.5 F. and the average mean minimum 57.4, the average mean daily range being 12.1. The average absolute maximum was 81.1 F., and the average absolute minimum 51.3, the average mean monthly range being 29.9. The average absolute maximum for January was 83.2, and the average absolute minimum for July 45.8.

During a period of ten years the figures for January and July were 77 and 47.3.

There were no frosts on the coast. The heat is tempered by sea-breezes during the day and in summer. In winter the temperature remains higher than inland. The range on the coast is not so great as at Riversdale itself and further north.

In the northern part of the Strandveld temperature conditions approximate more closely to those of the Renosterveld.

The mean amount of cloud at the coast for the years 1900-1902 was at Mossel Bay 4.7, 4.9, and 5.0, respectively. Its distribution over each month is shown in Table VI. the figures being the means for the triennium:—

TABLE VI.

January.....	4.9	May.....	3.1	September....	4.6
February.....	5.9	June.....	3.1	October.....	4.3
March.....	5.5	July.....	3.1	November.....	4.9
April.....	4.1	August.....	3.5	December.....	4.5

The mean for Durban is 4.7.

*Temperature of Sea on the Coast.*—\* The average temperature of the sea at the Knysna Heads 1901-1903 for each month was as in the Table VII. The coast receives the benefit of the warm Agulhas current which is the southern branch of the great westerly drift lying south of the equator. This warm current turns back on itself at Cape Agulhas and forms an easterly counter-current.

TABLE VII.

	1901.	1902.	1903.
January.....	70.4	66.0	66.5
February.....	71.1	70.1	67.1
March.....	64.2	69.7	64.1
April.....	64.8	65.4	62.7
May.....	63.5	63.1	60.1
June.....	61.5	59.0	57.6
July.....	56.8	57.2	55.4
August.....	58.6	57.9	56.8
September.....	57.5	57.7	57.7
October.....	57.8	59.7	59.2
November.....	61.7	60.9	60.7
December.....	64.6	66.1	66.2

(3) *Light.*—On the longest day, December 21st, at Riversdale the sun rises at 5.20 a.m. and sets at 7.44 p.m., giving a length of day of fourteen hours twenty-four minutes. On the shortest day, June 21st, it rises at 7.40 a.m. and sets at 5.30 p.m., giving a day of nine hours fifty minutes. These times refer to the centre of the sun on a true horizon disregarding the presence of mountains. (H.M. Astronomer, letter, October 20th, 1924.)

Owing to the absence of coast forest, and of scrub of great density the shade is hardly anywhere considerable. Accurate measurements with a Clements or Watkins instrument may be made later. Under deformed *Sideroxylon inerme* on the coast the shade is so dense that nothing grows. *Haemanthus albiflos* and *Crassula lactea* are shade resisters in the bush on the exposed Bokkeveld Shales on the shores of the Kafir Kuils River, and in the adjoining kloofs. In the dune valley scrub the shade is considerable, but even here there is a ground flora of delicate annuals; e.g. *Crassula glomerata*, *Torilis*

*africana*, *Aira caryophylla*, and *Scirpus cernuus* var. *subtilis*. *Hypoestes aristata* also favours such localities. Plantations of *Acacia saligna* have been formed near the coast for sand-fixation purposes, and have in these situations ousted the indigenous flora.

In shady places the mosses *Vesicularia sphaerocarpa*, *Ptychomitrium marginatum* and *Tortula pilifera* are present on the limestone, sometimes under shrubs, or in sheltered places among rocks.

(4) *Winds in the Strandveld*.—The chief winds here are:—

(a) Land and sea breezes. These are purely local and influence the coast belt only. They blow throughout the year, but are more marked in summer. Shortly after noon a breeze sets in from the sea in the direction of the land, and dies away towards sunset. About midnight a breeze begins to blow in the reverse direction, and this is known locally as the “Boesmanwind.”

(b) During the summer strong south-east winds occur frequently. Other winds blow at other times which will be described in detail in the next section. The effect of the former is seen on the dune scrub facing the sea consisting of *Sideroxylon inerme*, *Azima tetraacantha* and *Euclea racemosa*, and also on the plantations of *Acacia saligna*. *Sideroxylon*, although elsewhere a strong tree with an upright trunk and a spreading canopy, assumes here a shrubby type. The stems may reach a foot in diameter, but are bent often nearly to a right angle, and point in a north-westerly direction. Most of the withered branches are on the south-eastern side, and the leaf petioles are more numerous on the north-western aspect. This is due to increased transpiration, but the sand-blast also plays a part. The upper surface of the scrub is level, as if trimmed with shears. Bews has noted a similar appearance in Natal in connection with *Eugenia cordata*. (Plant Ecology of the Coast Belt of Natal, 1920.)

*Berg Winds*.—These are the hot or Foehn winds well known in the South-West. They are not, or at least hardly, felt at the coast, and belong essentially to the Renosterveld, but they occur also in the outer part of the Strandveld adjoining it.

## 2. Renosterveld.

### *Topography.*

This is known popularly as the Middelveld because it lies between the Strandveld and the Langebergen in the middle of the district; or as the Hardeveld in contradistinction to the blown sand of the Strandveld. The renosterbos, *Elytropappus rhinocerotis* is here dominant. In this portion lie most of the farms of the division, and the villages of Heidelberg, Riversdale and Herbertsdale. It extends for about 44 miles from the Duivenhoeks River to the Gouritz River, and varies from 5½ to 12 miles in width from north to south. It is characterised as a whole by gently undulating hills and valleys, the former often crowned by rocky outcrops and ridges. These hills are nowhere high,



and hardly obstruct the view, so that large areas of country are visible from any spot. Nevertheless there are no real plains of any great extent, except one lying south-west of Riversdale and south-east of Heidelberg. Some of the principal altitudes are the government beacons at Zwartklip 830 feet; Onverwacht 737 feet; Valsch River 919 feet; Karnemelks Vlei 867 feet; Riversdale 200-380 feet; and the beacon on the Riversdale hills 814 feet, the two last-named on the Witteberg Series; and Heidelberg village, 100 feet, on the Uitenhage Series.

This section is, generally speaking, fairly well watered, and more so in its upper northern part approaching the mountains. It is traversed from north to south by three large rivers, namely the Duivenhoeks and the Kafir Kuils, which arise in the Langebergen, and the Gouritz which has its source in the far inland regions north of them. Important tributaries are the Spiegel River running into the Duivenhoeks; Corente River, Klein Vet River (Naroo River), Zoetmelks River and Groot Vet River all eventually joining the Kafir Kuils. The Gouritz is fed by Eggers River, Wyders River and Valsch River.

Where the Gouritz River passes through the Table Mountain Series there are deep gorges with steep, precipitous bare rocky walls: in the Bokkeveld Series the walls are often high and steep, but less so than in the former, and they are more covered with soil which is argillaceous: in the Uitenhage Series the shores are lower still, more open, or at most with walls twenty to thirty feet high sharply cut in the softer soil by the current. The other rivers do not flow in such deep gorges in the Renosterveld. In the vicinity of all of them the hills are separated by, and cut into, a multitude of valleys and ravines running most east and west, down which streams run temporarily after rain to the main rivers. The Groot Vet River at Garcia's Pass and Hermans Hoek lies also in deep gorges, but these are in the Langebergen.

### *Geology and Soils.*

The Renosterveld or Middelveld corresponds closely, in area and limits, with the portions of the Division shown on the geological maps as occupied by the Uitenhage, Witteberg and Bokkeveld Series taken together.

*1. Uitenhage Series.*—This is an outlier extending from west of Slang River in the Swellendam Division to Assegaibos east of Riversdale village. It is about thirty miles long and eight miles wide at its broadest part near the western end. The Duivenhoeks and Kafir Kuils rivers both traverse it without exposing the underlying rocks. The main portion assumes the form of a long narrow valley, with innumerable diverticula between the hills of the Bokkeveld Series, and below the level of the surrounding country. Most of the marshes in the Division are situated here, and Heidelberg village is in this area. Elsewhere it rises into hills 600 feet high. A second outlier occurs near Gouritz Rivier on the farms Buffelsdrift, Bergfontein, Welgevonden, Zeekoesdrift, Wyders River and Zandfontein, and a valley runs towards Herbertsdale in the Mossel Bay Division belonging to it. Much of it consists of thin bedded shales, red and grey mudstones, conglomerates and clays.

There is a very remarkable mass of Melilite Basalt at Spiegel River forming an outcrop on the top of a hill 500 to 600 feet high. It is situated within the area of the Uitenhage Beds, but is of volcanic origin and not a part of them. It is about 300 feet in diameter from east to west. It is the only known example in the Uitenhage Series, and was unrecognized elsewhere until found later in the Sutherland Division. The rock is greyish black in colour, and the columns are indistinctly developed, but can be seen in a pit dug by diamond prospectors.

*II. Witteberg Series.*—Riversdale is partly built on a synclinal mass of Witteberg quartzite, six miles long by one wide, sloping upwards from the Vet River, and from 150 to 814 feet high. Much of this area is either bare rock, or is thinly covered with soil or gravel.

*III. Bokkeveld Series.*—This constitutes the remaining and largest portion of the area in which the Renosterbos is dominant. The beds consist of shales, quartzites and sandstones. There is an outlier near Coriente River and Remhoogte, and an extensive area occurs in the Klein Karroo.

There is an important condition over this area which confuses in many places any attempt to correlate soils with geological formations, namely the presence of cappings of gravels, surface quartzites and surface limestones. These cover the boundaries of the solid geology and the soil conditions must often depend on their occurrence. Generally speaking the caps are more siliceous than a soil formed directly from the underlying rock.

The Uitenhage Series consists largely of marls and gives clay soils with lime. Excellent bricks are made at Heidelberg from these clays.

The Witteberg Series gives soils consisting usually of argillaceous and arenaceous materials, not so markedly sandy as in the case of the Table Mountain Series, but nevertheless poor and thin.

The Bokkeveld Series produces clay soils containing a fair percentage of iron. Water from these is often brack, as is shown by such local names as Braklaagte, Brakkloof and Brakfontein.

#### *Climate of the Renosterveld.*

Climatic conditions over the whole of this are almost identical.

(1) *Rainfall.*—Full and reliable figures are available for—

Riversdale: 34.06 Lat. S. and 21.16 Long. E. 200 to 380 feet;  
Heidelberg: 34.05 Lat. S. and 20.58 Long. E. 100 feet; and  
Herbertsdale: 34.02 Lat. S. and 21.46 Long. E. 580 feet.

The average mean rainfall in inches and other particulars are given in the next table. From this it is seen to be a region of almost equally divided winter and summer rains. Heidelberg and Herbertsdale are on the western and eastern boundaries respectively, and Riversdale is situated centrally. The rainfall is about the same as near the coast, although spread over, perhaps, a smaller number of days.

TABLE VIII.

	Inches.	Wet days.	Summer, % age.	Winter, % age.
Riversdale (39 years).....	17.40	62	48	52
Heidelberg (38 years).....	17.12	82	51	49
Herbertsdale (15 years).....	17.37	64	49	51

The distribution of the rainfall over the year is shown in Table IX:—

TABLE IX.  
*Riversdale: Annual and Monthly Rainfall, 1895-1908.*

Year.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1895	2.30	0.25	0.21	2.35	0.27	1.00	0.16	0.42	1.02	0.75	0.61	1.08	10.42
1896	0.36	0.86	0.88	2.33	1.44	—	0.38	1.85	0.77	1.07	1.71	0.84	—
1897	0.53	0.60	0.86	0.44	2.07	0.77	0.50	0.65	1.36	1.12	0.50	0.26	9.66
1898	2.94	0.29	0.12	2.00	0.72	0.17	2.32	0.20	0.74	0.89	0.21	0.14	10.74
1899	0.10	0.19	1.60	1.72	1.68	1.07	0.33	0.33	0.72	1.01	0.00	1.79	10.54
1900	1.82	0.89	0.75	5.33	0.67	0.29	0.53	3.50	0.45	1.29	0.76	2.12	18.41
1901	0.83	3.86	0.76	1.16	1.62	1.30	0.89	0.74	4.44	1.28	2.08	0.11	19.07
1903	0.14	6.83	2.32	0.56	0.63	1.06	1.12	2.98	3.47	1.65	0.53	1.45	22.74
1904	2.16	1.82	0.72	1.68	0.34	0.63	1.33	1.65	1.51	3.56	0.29	0.76	16.45
1905	0.12	0.87	1.59	5.35	0.92	1.62	0.61	0.47	2.93	1.56	0.72	0.31	17.07
1906	0.00	0.20	1.06	2.91	3.10	0.96	0.32	0.62	1.23	4.20	0.75	8.50	23.85
1907	1.95	0.38	1.05	3.00	3.05	0.60	0.88	0.97	1.26	2.58	0.35	0.80	16.87
1908	1.40	0.25	1.05	3.10	0.85	7.36	1.25	1.90	0.45	4.65	0.75	0.75	23.76

From this series statistics for 1902 are missing. A further cycle for Riversdale is shown in the following table. The year 1924 was exceptionally dry and in the Klein Karroo there were total failure of crops, wholesale destruction of small stock, and famine conditions necessitating government relief.

TABLE X.

	1921.	1922.	1923.	1924.
January.....	0.29	2.86	0.87	0.66
February.....	3.65	1.97	0.54	0.85
March.....	1.49	3.05	0.15	0.39
April.....	2.19	1.23	3.65	1.21
May.....	0.95	1.40	2.89	0.84
June.....	2.65	0.81	1.79	1.33
July.....	1.31	1.69	0.93	0.58
August.....	2.93	0.94	0.90	2.01
September.....	1.50	0.80	0.70	0.49
October.....	0.74	1.21	2.67	0.84
November.....	0.42	2.22	2.70	1.49
December.....	2.10	0.70	0.12	0.90
TOTAL.....	20.22	18.88	17.91	11.59

In winter mists lie long over the basin of the Uitenhage Beds and along the rivers, mapping out these areas, and often not disappearing until 10 a.m. or even later. They bring, however, much additional moisture.

Soft hail falls rarely as short showers in early summer and does little or no damage. Snow is seen occasionally on the mountain peaks from 3,500 to 5,000 feet from May to October, and lies from one to four days.

Thunderstorms occur seldom and are of short duration, sometimes without rain or with slight showers, or again accompanied by copious downfall. Precipitation on the whole is not due to them in any marked degree.

A request to the Meteorological Department for information regarding Relative Humidity elicited no reply. The average of the means of dry and wet bulb Thermometer readings, calculated over a period of six years is shown in Table XI:—

TABLE XI.

Month.	Dry Bulb.	Wet Bulb.
January.....	69.8	64.2
February.....	70.3	64.6
March.....	65.6	62.3
April.....	59.4	57.4
May.....	57.0	52.0
June.....	52.7	46.7
July.....	50.8	44.9
August.....	54.0	46.6
September.....	57.2	51.6
October.....	61.6	56.1
November.....	65.8	58.9
December.....	68.5	63.2

They are taken partly from the records of the Rev. M. Johnson, and partly from other records.

## (2) *Temperature in the Renosterveld.*

*Heidelberg.* The average mean maximum during the years 1900 to 1903 was 75.6° F. and the average mean minimum 50.4° F., the average mean daily range being 25.2° F. The average absolute maximum was 90.7° F. and the average absolute minimum 40.5° F., giving an average mean monthly range of 50.2° F. The highest temperatures were in October (103.3° F.), November (102° F.), and January (102° F.). Frosts were recorded in June, July, and August, the lowest temperature being 29.7° F. The average absolute maximum for January was 95.9° F., and the average absolute minimum for July was 31.7° F.

*Riversdale.*—The figures for December and January in each year are incomplete through absence of the observer, so that it is impossible to give the average mean maximum and mean minimum for the year. The figures for the other months, taken in a Stevenson

screen and calculated over a period of five years, are given in Table XII. The highest temperatures were in January (105° F.), February (114° F., 111° F. and 104° F.), March (111° F. and 104° F.), April (102° F. and 101° F.), May (106° F.), October (102° F.), and November (107° F. and 104° F.). Frosts were recorded in June, July and August, the lowest temperature being 29° F. They are thus never severe and ice rarely forms.

When snow lies on the summits of the Langebergen, and the wind blows from the north-west, the temperature south of the range is appreciably lowered.

TABLE XII.

	Average Mean Maximum.	Average Mean Minimum.	Average Absolute Maximum.	Average Absolute Minimum.
January.....	—	—	—	—
February.....	87·9	60·0	105·8	51·4
March.....	82·2	58·2	100·2	46·6
April.....	82·7	53·1	98·4	44·8
May.....	75·1	48·3	90·8	37·6
June.....	67·7	42·0	81·0	32·6
July.....	68·2	44·3	80·6	32·8
August.....	70·4	43·8	80·6	32·2
September.....	72·0	46·6	87·4	36·4
October.....	75·9	49·3	92·1	39·8
November.....	78·1	54·4	98·4	43·6
December.....	—	—	—	—

Comparing temperature conditions in the Renosterveld with those at the coast there is firstly, a greater range of temperature in the former; secondly, hotter summer and colder winters with the presence of occasional frosts in the former; and thirdly, at the coast the heat is moderated by the sea-breezes, so that there is a greater equability of temperature, not so low in winter and not so high in summer.

The mean amount of cloud at Riversdale for each month over a period of four years is given in Table XIII. Those for January and December are defective.

TABLE XIII.

January.....	—	May.....	4·1	September.....	4·9
February.....	4·9	June.....	4·9	October.....	5·4
March.....	5·6	July.....	4·7	November.....	5·0
April.....	5·3	August.....	4·5	December.....	—

(3) *Light in the Renosterveld.*—*Elytropappus rhinocerotis* affords little shade, and many annuals and grasses grow among it. *Acacia karoo* in the park like patches in the area corresponding to the Uitenhage Series casts a very light shade, grasses growing right up to the trunk, so that it hardly at all interferes with plant growth. There are several plantations here of considerable size of *Eucalyptus corynocalyx* F. von M. (= *E. cladocalyx* F. von M.), the trees planted at intervals, and without younger ones between them. The shade is

fairly dense and the sun when overhead does not of course illumine the dark central patch around each tree. When the rays fall laterally these patches receive more light. All grasses have disappeared as well as *Relbania genistaefolia*, *Rhus lucida*, *Sclago corymbosa* and nearly all the shrubs which formerly grew on the site of the plantations. *Elytropappus rhinocerotis* and *Mcsembrianthemum parvifolium* are among the last to hold out, and next comes *Asparagus capensis* bearing in this situation hardly any flowers. *Crassula acutifolia*, however, still flowers freely.

Among *Elytropappus*--the shrubs of which have sometimes to be separated to see them--are several species of *Holothrix*, *Bartholina pectinata*, *B. Ethelae*, *Disperis Bolusii*, *Hyobanche sanguinea*, *Barleria pungens* and *Blepharis capensis*. The commonest mosses are *Tortula pilifera*, and *Triquetrella tristicha* growing even in the shade, the density of which is, however, nowhere great.

In the *Aloe* scrub in the early pioneer stage there is little or no interference from shade; but later in the secondary stage, a more or less dense canopy is formed by the appearance of other shrubs, and scandent plants such as species of *Asparagus* and *Sarcostemma riminalae*, and the shade becomes denser. The usual plants on the surrounding veld become gradually shaded out, such as many annual *Scrophulariaceae*, and grasses such as *Lasiochloa ciliaris* and *Pentastichis currifolia*. Finally *Relbania genistaefolia* disappears and last of all the *Renosterbos* itself. *Stipa dregeana* sometimes grows here (commoner, however, in mountain woods), and also under *Acacia karoo*, and is a good shade resister. In the *Aloe* scrub in rocky situations only ferns and cryptogamic species are found, as the light is greatly diminished.

#### (4) Winds in the Renosterveld.--

(a) *Berg or Föhn Winds*.--These are the hot winds of the south coast districts, and are similar to those of Namaqualand, Switzerland, and the Chinook of Canada. They begin about the first week in March and last until August, but rarely blow during other months. They are less prevalent during some years, but in others there may be two to four during a month. They come from the north-west, and those living in a district where they occur can often in the early morning foretell their advent during the day partly by bodily sensation and partly by a distinct orange glow in the sky. They last from twelve to thirty hours, and produce a feeling of mental and physical exhaustion. They cause desiccation of the vegetation by evaporation, which has been estimated at two inches in twenty-four hours, and result in decreased humidity and reduction of the holard. Although tender plants in a garden appear at first to have suffered greatly, it is surprising to see how many eventually recover. Young plants, shoots and seedlings are, however, frequently burnt up. In the Riversdale Division these winds are popularly believed to hasten the ripening of guavas (*Psidium Guayava*) and custard apples (*Anona reticulata*). Farmers take advantage of their occurrence to set fire to the veld, which becomes more inflammable. During the berg-wind the barometer falls, but rises afterwards. The wind usually ends suddenly and is followed by cooler weather or rain from the west or north-west. The Langebergen usually appear clear and blue without any cloud mass, in which respect the berg wind differs from the

hot winds of other countries where the presence of the cloud mass is usual.

(b) In summer, and from October to March, south-east winds are common. East winds are also frequently recorded, but north-east winds are less common. From April to October north-west and west winds are prevalent. Though rain sometimes comes from the south-east, the north-west winds are the main rainbringers. North winds are rare. Taking the scale of wind force as 0 to 12, during a period of eleven years it is recorded as 3 or "strong" on one or two occasions, often as 2, but never stronger. These west, and south-east or east winds play an important part in seed dispersal.

### 3. The Langebergen.

#### *Topography.*

This mountain range runs roughly east and west. Its southern side is cut into many kloofs or ravines, directed mostly north and south, with small woods in them, which are the remains of a forest formerly much more extensive. The foot hills and mountain slopes appear smooth from a distance, but carry a dense vegetation, which is lower and more ericoid on the former, and of the "fynbos" type and without forest trees on the latter. On the northern side the mountains appear more forbidding, the rocks more bare, sterile and greyer from lichens, but on closer inspection they have an abundant vegetation although very much less luxuriant than on the other side. The rivers already mentioned, except the Gouritz River, and many nameless streams, have their sources in the southern slopes. Four mountain passes traverse the range in the following order from west to east; viz.: Gysmanshoek Pass, Garcia's Pass, a bridle path between the Schoorsteenbergt and the Doodkistberg, and Cloete's Pass between the Vryers Berg and Goliath's Berg. Three of these have now roads, and the first-named has existed since before the time of Thunberg and Masson, in whose writings it appears under the name of Plattekloof.

Some of the mountain summits are plateaux, 4,000 feet above the level of the sea, and afford pasturage for cattle, the frequently recurring name Paardeberg referring to the practice of sending horses there from the plains to escape South African horse-sickness. The principal altitudes are:—government beacons on Kampsche Berg 4,470 and 4,518 feet, Mozambique Kop 4,351 feet, Oudebosch 4,407 feet, Langeberg 5,006 feet, Witte Els Berg 3,825 feet, and Vryers Berg 3,800 feet.

Near the sources of rivers there are marshes, and in places, notably at Corente River, the deep, moist, black soil is cut by the dark-coloured mountain streams into deep channels leaving intervening masses of earth, resembling the "moss hags" of Scotland. These harbour some rare orchids.

#### *Geology and Soils.*

The Langebergen belong to the Table Mountain Series. The sides are usually sloping, although sometimes precipitous. The soil is sandy, poor and sour. A loose open shingle is frequent. Near the base, as just stated, the soil takes on a rich dark appearance from the presence of organic matter. The water is dark-coloured but nevertheless soft and potable.

*Climate of the Langebergen.*

(1) *Rainfall*.—Much of the moisture on the summits and upper slopes is derived from the south-easterly clouds, and falls as rain, or is condensed by the vegetation. These clouds are driven in from the Indian Ocean. The only observation station is at Grootvader's Bosch, 1,000 feet, on the western border of the Division, 33.59 Lat. S., and 20.52 Long. E., where the mean annual rainfall for 18 years was 40.68 inches. Rain fell on an average on 83 days, the summer percentage being 57 and the winter percentage 43. No exact observations have ever been taken for the higher portions of the Langebergen, but at 4,000 to 5,000 feet, the rainfall plus condensation of moisture would be very much greater.

Table XIV shows how the rainfall was distributed over the year.

TABLE XIV.

January.....	1.91	May.....	0.45	September.....	3.18
February.....	7.64	June.....	1.28	October.....	4.09
March.....	2.86	July.....	1.54	November.....	4.94
April.....	3.75	August.....	4.25	December.....	4.04

This is for the period 1900 to 1903 when the total annual rainfall varied from 33.51 inches in 1900 to 51.88 inches in 1902. In the latter year 20.14 inches fell in February alone, and 9.02 inches in a single space of twenty-four hours in the same month. These extremes tend to be obliterated in a long series of statistics, but show up more distinctly in shorter ones.

(2) *Temperature*.—There are unfortunately no meteorological stations on the Riversdale mountains, such as exist in the Cape Division, and consequently no statistics. There are of course a decrease of atmospheric pressure with increasing altitude, and also a decrease of temperature. The highest peak is 5,006 feet or 1,540 metres, and the fall in temperature averages 0.57 C. for every hundred metres. It has been noticed repeatedly by the writer during nights in winter when travelling from 100 feet to an elevation of 1,200 feet, that the higher altitude was warmer than the lower, and that there was an inversion of temperature. Animals and stock find this out for themselves when seeking shelter in winter.

(3) *Light*. There is a greater intensity of light in the open in the higher parts owing to the air being more rarified, and the amount of atmospheric dust much less. Chemical action of the sun's rays is of course much greater here than in the coast strip.

In the mountain forests with their lianes, shut in often on two and three sides by rocky precipices and screes, the shade is intense. Often nothing but cryptogamic plants, many epiphytic, are seen. Mosses such as *Braunia secunda* and *Leptodon Smithii*, and lichens like *Ulsnea barbata* are common. Among phanerogamic plants *Plectranthus fruticosus* is a good shade resister. *Peperomia retusa* is frequent on stones and roots of trees, and *P. reflexa* occasional on tree trunks. Where there is more light *Schoenoriphium lanceum* grows on the floor of the forest. *Stipa dregeana*, *Galopina circacoides*, *Adenocline*



*mercureialis* and *Leidesia capensis* occur here, and *Angraecum pusillum* and *Vittaria isoetifolia* on the trees. An *aloe* of the section *Prolongatae* allied to *A. laxiflora* is common on the borders of woods.

A young plantation of *Acacia mollissima* var. *decurrens* on the mountain approaches shows on its floor a greatly diminished native vegetation compared with that outside. In time this introduced tree will drive out completely all the indigenous species.

(4) *Winds*.—There are here—

- (a) the same southerly winds as at Riversdale.
- (b) berg winds, and
- (c) local winds which are chiefly in the valleys.

When snow lies on the mountains in winter there are (d) cold winds from them towards the plains.

#### 4. The Klein Karoo.

##### *Topography.*

The Riversdale portion of the Klein Karoo lies to the north of, and parallel with, the Langebergen. It extends for about forty miles from east to west; and varies from six to eight miles from south to north. It is only a portion of a much wider area with many towns and villages in it such as Ladismith, Calitzdorp and Oudtshoorn. The part here dealt with is an undulating plain with stony ridges and numerous and rocky hills, varying in altitude from 1,000 feet to 1,700 feet. The Government beacon at Muiskraal is 1,611 feet above sea level, but the country there is not typically karroid. It is fairly well settled and ground was formerly very valuable for ostrich-farming. It is intersected by many water courses which are dry except after rains. The Groot Rivier runs S.S.E. through a portion to join the Gamka River, the two forming together the Gouritz River; and even the Groot Rivier exists frequently as a mere series of disconnected pools. Although not really desert its aspect is desert like, and the prevailing colour—especially when a great extent is viewed at a distance—is brown. The hillsides and flats on the Bokkeveld Series are covered in places with large stretches of white stones, and these “quartz” areas possess a special and interesting vegetation. The shrubs in the Klein Karoo grow in a scattered manner, with intervening bare areas of hard, baked ground, coming near Warming’s description of “fellfield.” It is said to correspond closely to some parts of Arizona.

##### *Geology and Soil.*

The area considered belongs to the Bokkeveld Series and consists of sandstones and shales. The latter crop out everywhere both on the hills and on the plains. The cleavage yields tall, massive fencing poles of stone. The soil is derived from the disintegration of the above, and although dry and baked, is in parts extremely fertile. Where it meets the Table Mountain Series “junction soils” of special composition occur. (Agricultural Soils of Cape Colony, Dr. C. F. Juritz.)

*Climate of the Klein Karoo.*

(1) *Rainfall and Humidity.*—The rainfall, over the Klein Karoo generally, varies from eight to fourteen inches annually. Although the amount at the end of the year may be considerable, yet there are often periods of two to five years of intense drought, when lambs have occasionally to be destroyed and even the succulents wither and die. There is little water and few crops can be grown except near the Langebergen. The climate in some degree approaches the dry continental type.

The nearest available meteorological station is at Amalienstein 33.29 Lat. S. and 21.29 Long. E. It is 58 miles from the coast, and 1,570 feet above sea level. The average mean rainfall for 46 years was 13.07 inches; the average number of wet days 61; the summer percentage 52 and the winter percentage 48. The distribution of the rainfall over the year calculated over a period of four years is shown in Table XV. (Report Met. Comm. 1900-1903.)

TABLE XV.

January.....	0.82	May.....	0.57	September.....	1.26
February.....	2.53	June.....	0.72	October.....	1.19
March.....	1.59	July.....	0.65	November.....	1.51
April.....	1.56	August.....	1.13	December.....	0.60

*Relative Humidity.*—The annual average was 70.2, and the means for each month throughout the year are recorded in Table XVI.

TABLE XVI.

January.....	58.7	May.....	78.7	September.....	75.0
February.....	68.2	June.....	80.0	October.....	65.0
March.....	72.7	July.....	82.7	November.....	62.5
April.....	82.7	August.....	81.2	December.....	56.5

(2) *Temperature of the Klein Karoo.*—The average mean maximum is 76.8° F. and the average mean minimum 47.1° F., the average mean daily range being 19.7° F. The average absolute maximum is 91.2° F., and the average absolute minimum 36.8° F., the average mean monthly range being 54.4° F. The average absolute maximum for January was 101.8° F., and the average absolute minimum for July was 28.5° F. The highest temperatures recorded were in December (106° F.), January (102° F.), February (104° F.) and March (104° F.). The lowest were in July (24.8° F.), frosts occurring from May to October or even November, damaging the orchards and bean crops. (Rev. Carl Prozesky, in litt.)

The mean amount of cloud for the years 1900-1903 was 3.5, 3.9, 3.9, and 3.7. The average of the means for each month during the same period appears in Table XVII.

TABLE XVII.

January.....	3.0	May.....	3.1	September.....	4.4
February.....	3.8	June.....	3.4	October.....	4.3
March.....	3.9	July.....	3.1	November.....	3.9
April.....	4.4	August.....	3.8	December.....	3.2

(3) *Light*.—The intensity of light is greater than in the Rhenostræveld and coast regions. It is often an intense white, almost blinding light. The only shade, and that slight, is in the river beds under *Acacia karoo*, *Rhus lancea*, and a few other trees as *Pappea capensis*.

(4) *Winds*.—The most windy months are October, November and December, the winds coming from the north or north-east, strength 2 to 4. During winter the north winds sometimes cause a rise in temperature, and in summer south or south-east winds cause a fall. South-west winds often presage the breaking up of droughts, as they are the rain-bearing winds. (Rev. Carl Prozesky in litt.)

## VEGETATION OF EACH REGION IN DETAIL.

### I. THE STRANDVELD.

#### (1) At the Coast.

(a) *On a rocky foreshore*.—Nearest the sea, within reach of high tides and spray, there is only one plant *Salicornia rupicola*, wedged in crevices of rocks of the Table Mountain Series.

Above high water mark on the beach there is a zone of sand mixed with shingle, dry seaweed, and the refuse thrown up by the sea. Here there is a number of arenicolous plants, *Anthericum revolutum*, *Cnidium suffruticosum*, *Chenolea diffusa*, *Statice scabra*, *Plantago carnosia*, *Dimorphotheca fruticosa*, *Sporobolus pungens* and *Silene crassifolia*. A little further back the *Sporobolus* runs together into small compact areas, and is found with *Stenotaphrum glabrum*, *Indigofera tomentosa*, *Sutera tristis* and *Manulea tomentosa*. Occasionally *Euphorbia Muirii* extends down from the sandy dunes and limestone hills. Most of these grow on rock ledges in sand as well, and reach the mobile dunes. On low rocks on this beach occur *Mesembrianthemum litorale*, *Hebenstreitia cordata*, *Cincaria geifolia* and an *Othonna* as yet undescribed Muir 3128. In damp places where fresh water percolates there grow *Scirpus costatus*, *Ficinia aphylla*, and *Juncellus laevigatus*.

Between this beach zone and the summit of the mobile dunes two conditions are met with. In places there is an almost impenetrable dune scrub forming a sea wall, consisting of *Sideroxylon inerme* of a low shrubby type, with *Rhus crenata*, *Azima tetracantha*, *Zygophyllum Morgsana*, *Z. flexuosum*, *Euclea racemosa*, *Passerina rigida*, *Osteospermum moniliferum* and *Metalsia muricata*, welshed together by the lianes *Rhoicissus Thunbergii*, *Sarcostemma viminale*, *Cissampelos capensis*, and various species of *Asparagus*. There is no ground flora on the loose, bare sand underneath, and the whole mass is like a well trimmed flat-topped hedge owing to the south-east winds.

Beyond this, for a hundred yards, the mobile dunes are more open, and the shrubs mentioned occur in a scattered manner. *Myrica cordifolia* sends prostrate stems in all directions, but further back still becomes an upright shrub; great clumps of an unnamed *Phylica* Muir 3121 grow freely, and an occasional plant of *Euphorbia mauritanica*. On the ground, covering intervening spaces are *Mesembrianthemum dulce*, *M. Muirii*, *M. crystallinum*, *Cotyledon orbiculata*, *Senecio abruptus*, *S. elegans*, *Othonna carnosia* and *Doria perfoliata*. *Viscum capense* is common, and *Hyobanche sanguinea* grows in the loose sand.

(b) *On a sandy foreshore*.—Here the appearance is somewhat different. Nearest the sea there is a number of isolated hillocks, conical or truncate, formed and covered by *Scaevola Thunbergii*. The largest of these is 190 yards from the border of the mobile dunes, and rises from the level flat sand eighteen feet high and 124 yards in circumference. It has taken forty-five years for *Scaevola* to build it, and in "blow-outs" its roots are seen penetrating the sand everywhere. It is nearly always in flower, sets much seed, and the branches when pulled out by children are floated away and often form miniature mounds a foot or so high before the next spring tide. A complete list of plants on the hillocks comprises *Senecio elegans*, *S. Burchellii*, *Stoebe cinerea*, *Mesembrianthemum Muirii*, *Chironia baccifera*, *Anthericum revolutum*, *Agropyrum distichum* and *Scirpus antarcticus*. Young hillocks are covered with *Scaevola Thunbergii* in pure culture, and the next plant to come in is *Agropyrum distichum* which sends roots through the sand, and grows through it even when submerged by sand storms. *Charadrius marginalis*, a limicole bird, often nests here.

Between the hillocks and the base of the dunes there are only a plant or two of *Agropyrum distichum*, and a herbaceous species of *Salicornia*, which is rarely in flower. They grow on the flat ribbed sandflats, and are sometimes covered at high tide.

The sand dunes rise here terrace on terrace to a height of several hundred feet, for the most part bare and dazzling in the sun. Rarely a few green patches are seen, and an occasional plant of *Anthericum revolutum*, which also collects sand into small heaps about a foot high. When vegetation is cleared away from the sand dunes by the spade or after fire it is the first plant to return. *Scaevola Thunbergii* also occurs in this zone abundantly. In the green patches *Passerina rigida* and *Myrica cordifolia* replace *Scaevola Thunbergii*, otherwise the composition is the same as on the *Scaevola* hillocks. *Microsteplium nicum* is of rare occurrence, and *Sutherlandia frutescens* assumes the more xerophytic form of the variety *tomentosa*. Near the summit the winds have hollowed out a few deep, funnel-shaped cavities fringed with *Helichrysum teretifolium*, *Stoebe cinerea* (often here the host of *Thesidium Thunbergii*) and *Senecio elegans*. At the bottom where it is damp *Satyrium stenopetalum* grows luxuriantly.

Fresh water can be found at a depth of three feet anywhere on the foreshore just above high water mark. Wells sunk here for water by visitors are sometimes near enough to the sea to be flooded by a spring tide.

(c) *Summit of the Mobile Dunes*.—The sand on the summit is nearly always in a state of movement, even when the wind is slight, and is blown about in low clouds. The highest ridges are crowned by isolated masses of sand, six to nine feet high with vertical sides. They are the result of wind erosion on a once continuous margin, which has left them raised above the surrounding level. They are covered with bush of the dune scrub type but the constituents are not the same everywhere. In one place *Rhus crenata* is dominant, in others *Metalsia muricata*, *Passerina rigida*, or *Stoebe cinerea*, all ranging from five to ten feet in height. More usually, however, combinations of these four species are found, and also *Sideroxylon*

*inermis*, *Zygophyllum Morsana*, *Rhus lucida*, *Azima tetracantha*, *Gymnosporia laurina*, *Ostcospermum moniliferum* and *Rhoicissus Thunbergii*. Elsewhere the summit may be more or less level, and beginning to show signs of fixation. The first *Restiad* appears here, namely *Thamnochortus insignis*, and also *Helichrysum retortum*, *Senecio erosus*, and an occasional grass such as *Ehrharta erecta* and *E. calycina*. Many of the plants here such as *Senecio elegans*, and the introduced tree *Myoporum acuminatum* assume a succulent aspect different from their appearance elsewhere.

(d) *Landward side of Mobile Dunes and Dune Valley Scrub.*—

On the landward side the dunes are fixed, and the vegetation becomes stabilised. In addition to most of those on the summit the following species grow on the slopes: *Psoralea bracteata*, *Restio Eleocharis*, *Drosera microcarpa* (abundant), *Myrica quercifolia*, *Agathosma apiculata*, *Chironia baccifera*, *C. scabrifolia*, *Tetragonia fruticosa*, *Pelargonium bctulinum*, *Helichrysum maritimum*, and *H. teretifolium*. Common succulents are *Mesembrianthemum maritimum*, *M. criniflorum*, *Othonna carnosa*, and *Kedrostis nana*. *Ficinia aphylla*, *Scirpus membranaceus*, *Brizopyrum capense*, and *Polypogon monspeliensis* appear where the sand is fixed. *Acacia saligna* has been planted, and grows well.

In the valley at the base of the dunes the scrub consists of many shrubs and small trees ten to fifteen feet high, viz: *Sideroxylon inerme*, *Gymnosporia laurina*, *Mystroxydon sphaerophyllum*, *Olea verrucosa*, *O. capensis*, *Pterocelastrus variabilis*, *Oxyris abyssinica*, *Bupleurum difforme*, *Cassine capensis* and *Myrsine africana*. The three species first on the list are most common. In the layer of scandent plants are *Sarcostemma viminalis*, *Rubia petiolaris*, *Pelargonium peltatum*, *Solanum geniculatum* and *Cassytha ciliolata*. On the borders of the scrub, and in more open places inside it, are found *Crassula glomerata*, *C. fastigiata* and *Euphorbia Muirii*. *Torilis africana*, *Scirpus cernuus* variety *subtilis* and *Bupleurum Mundii* form the ground flora where the shade is not too great. About the estuaries, between the dune valley and the coast flats and near dwellings are many ruderal grasses, *Phalaris minor*, *Hordeum secalinum*, *Bromus maximus*, *B. patulus*, *Lolium temulentum* and *Briza minor*.

*Seeds brought by Ocean Currents.*—I have found in the beach-drift in order of frequency six species:—*Caesalpinia bonducella*; *Entada scandens*; *Mucuna* sp. with compressed seeds; *Mucuna urens*; one possibly *Dioclea reflexa*; and one 30-40 m.m. long, 15-25 m.m. broad, 10-13 m.m. thick, oblong or ovate, flattened, dark brown.

*Seashore Migration.*—Some of the above plants mentioned have a wide littoral distribution. *Sporobolus pungens*, *Dimorphotheca frutescens* and *Microstephium niveum*, to mention three examples only, extend to the Cape in one direction and to Natal in the other. Other examples could be adduced, and as Professor Bews has said, the seashore is an easy pathway. (Plant Forms, p. 31.)

(e) *Coast Flats.*—The dune valley is from one quarter to several miles distant from the limestone hills. The intervening sandy flats differ from the inland flats of the Strandveld by having few *Proteaceae* and few *Ericaceae*. They are dry and have no vleis. The principal shrubs are *Pterocelastrus variabilis*, *Rhus glauca*, *Gymnosporia*

*laurina*, *Callumia setosa*, *Aspalathus elongata*, *A. ciliaris*, and *Osteospermum moniliferum*. Scandent plants are abundant, and on a single shrub of *Pterocelastrus variabilis*, seven feet high, were noted *Galium tomentosum*, *Sarcostemma viminalis*, *Solanum geniculatum*, *Euphorbia Burmanni*, *Cynanchum obtusifolium*, *Dolichos gibbosus* and *Asparagus thunbergianus*. Others in this area are *Rhoicissus Thunbergii*, *Cissampelos capensis* and *Corydalis vesicaria*. Occasional straggling climbers are *Rubia petiolaris*, *Astephanus neglectus*, *Convolvulus hastatus* and *Kedrostis Schlechteri*. Herbs are represented by *Cotula turbinata*, *Relbunium sessiliflorum*, *Heliophila linearifolia*, *Monsonia ovata*, *Geranium incanum* and *Mesembrianthemum criniflorum*. *Hyobanche sanguinea* and *Orobanche ramosa* are parasites common here. Among *Monocotyledons* are *Ferraria undulata*, *Massonia pustulata*, *Lachenalia pendula*, *Satyrium carneum*, *S. odoratum*, *Habenaria Bonatea*, *Stenotaphrum globosum*, *Setaria flabellata*, *Aristida capensis*, *Briopyrum capense*, *Ficinia paradoxa*, *F. pinguetor*, *F. bulbosa* and *Schoenus nigricans*. *Cadaba juncea* is frequent.

(f) *Halophilous Marshes*.—There are few of these, small in extent and situated in the neighbourhood of the estuaries. They are covered periodically by spring tides and are constantly salt or brackish. Since some of them are traversed by rills of fresh water, care has to be exercised to distinguish the initial stages of the halosere from those of the psammose. The commonest plants are *Statice scabra*, *S. linifolia*, *Orphium frutescens*, *Samolus porosus*, *S. Valerandi*, a species of *Salicornia* still undetermined Muir 166, *Chenopodium diffusa*, *Lepigonum marginatum*, *Frankenia laevis* and *Sporobolus pungens*. *Cotula filifolia* also occurs in salt marshes but is more partial to fresh water. The highest zone, reached rarely by the highest spring tides, where the water is nearly or altogether fresh, shows *Juncus maritimus*, *Scirpus maritimus* and *S. littoralis*.

On the mud flats *Salicornia* sp. 166 forms a continuous carpet, covered at every tide. In the course of time these flats become more and more raised by additional deposits, and then *Sporobolus pungens* comes in and the *Salicornia* becomes diminished. In semi-brackish damp places *Aster ficoides* appears, also associated with *Sporobolus*. A species of *Zostera* is a common submerged marine aquatic in the estuary of the Kafir Kuils River.

(g) *The Inland Salt or Brack Areas*.—It is convenient to consider these areas here, although they belong to another section geographically. They comprise firstly the salt pans, and secondly the saline patches on which *Salicornia hottentotica* is dominant. They are types of the salt or "brak" places of the interior, concerning which Professor J. W. Bews has said that more information is desirable. (An Account of the Chief Types of Vegetation in S.A. 1916.)

(1) *The Salt pans*.—These are at Zoutpan, twelve miles from the sea, but have no connection with the latter by streams or intermediate lagoons. There is a series of high rocky ridges and sandy valleys between them and the coast line. They lie in the outer portion of the sandy flats of the Strandveld, and are surrounded by the ordinary normal vegetation of that region such as *Restionaceae*, and *Proteaceae* especially *Leucadendron Galpinii*. This stops suddenly near the borders of the pans, and almost without thinning out of species. The

gently shelving shores are densely covered by a continuous zone four to eight feet wide of *Sporobolus pungens*, in which *Frankenia Krebsii* occurs as the subdominant species. Other plants here are *Statice scabra*, *Plantago carnosu*, *Chenolea diffusa*, *Atriplex Halimus*, *Mesembrianthemum micranthum*, *M. Muirii*, *M. edule*, *Salicornia hottentotica* (growing sparsely), *Lycium sp.*, and *Juncus sp.*, the two latter deflorate at the time of the visit and not determinable. *Chironia baccifera* and *Orphium frutescens* grow further away. *Mesembrianthemum Muirii* has an attenuated, poor appearance and its fruit is never collected from this locality for eating or jam making. The floors of the pans are level and carry no vegetation.

(2) The *Salicornia hottentotica* Patches.—Several of these alkaline areas exist in the Riversdale Division, notably in the Renoster-veld near the village, 25 to 27 miles from the sea, and there are others near Albertinia, Melkhoutfontein aan de Gouritz Rivier, and Vogel Vlei at distances varying from three to twelve miles from the sea. *Salicornia hottentotica* C. E. Moss is the only member of the genus found in non-maritime localities, and is considered by farmers as an indicator of an alkaline or "brak" soil of little or no market value. The areas near Riversdale are fully exposed and in the open. *Salicornia hottentotica* is a shrub, growing socially and varying in height from six to twenty-four inches. It covers small mounds of soil which are separated by bare areas of salt-covered clay, and raised one to two feet above them. The clay sets very hard after rains, and shows fissures in hot weather. In summer there is a thin white efflorescence of salts deposited in many places. Elsewhere the ground may be level and without mounds. Associated with the dominant shrub are many succulent and other plants:—*Mesembrianthemum micranthum*, *M. luteum*, *M. praeacutum* and one or two other species of the same family, *Exomis oxyrioides*, *Atriplex semi-baccata*, *Lycium Kraussii*, *Cotyledon orbiculata* (abundant), *Kleinia radicans*, *Bulbine praemorsa*, *Stapelia variegata* and *Sporobolus pungens*. A very curious plant, abundant here but not peculiar to these areas, is *Euphorbia clandestina*, and in a space ten feet square forty of these plants were counted. On the borders of the patches, and where the alkalinity is less, many more species come in, but the description given applies to an area of marked salinity.

*Salicornia hottentotica* also grows just outside the real areas in open places among *Acacia karoo* and even under these trees, but sparingly and exceptionally.

## (2) The Inland Region of the Strandveld.

Although the type of vegetation over the whole of the Strandveld is very largely sclerophyllous, there are some differences between that on the rocky ridges and hills, and that on the sandy flats. The composition of each therefore will be considered in detail.

Certain remarks by Willis (Age and Area, 1922) may first be quoted:—"Nothing has been a subject of greater controversy than the effects of the composition (of soil) upon the vegetation which it carries. . . . It is comparatively rare for any plant to be confined in its growth to one kind of soil only. . . . There is no doubt that if in the same climatic and other general conditions there exist two belts of different soils, these will be covered with floras that will be

differently constituted in detail, but it is comparatively rarely that a species will not occur on both, though it may be common on one and very rare on the other. The only chemical constituents present in the soil that really seem to have a determining effect in allowing some species and excluding others are calcium carbonate (chalk or limestone) and sodium chloride (salt)."

Researches on the composition of soils by Dr. B. Marchand and others may eventually render it easier to draw more definite conclusions in South Africa than has been hitherto possible. The writer is chiefly concerned with the accumulation of facts, and leaves it to others to make deductions. Whenever, in the description of types of vegetation and their composition, there would appear to be any coincidence, however slight, between these and the soils or even the solid geology, it is recorded, although invariably with due reserve. The habitats given for plants are for the Riversdale Division only.

(a) The Hills and Ridges.—These are composed of Recent Limestone out of which the lime has not been leached, and many rare plants occur here. Such limestone areas outside South Africa have been found to be marked by a number of species which are usually confined to them, at least in the same region, and an attempt is made here to ascertain how far this applies to Riversdale. Proceeding northwards for five hundred yards from the dune valley the first plant which is conspicuous on these hills is *Erica spectabilis*, which is apparently only recorded up to the present from this locality and the "chalk" hills near the Bredasdorp coast. It occurs in pot-holes and fissures in the limestone and as far as is known in this division is confined to it. *Massonia pustulata* is also common in similar cups, but is not an obligatory chomophyte, as it is also found on the sandy flats. The succession on dry sloping rock surfaces can be seen here, either in partial shade or in the open. The first stage appears to be made up of lichens followed by the mosses *Tortula pilifera*, *Vesicularia sphaerocarpa*, and *Ptychomitrium marginatum* among which appear later *Crassula glomerata*, and the newly-discovered *Crassula uniflora*, for which this is as yet the only locality. Other plants on the limestone ridges are *Aemadenia densifolia* (limestone hills only), and *Dorca microcarpa* (limestone hills and landward side of sandy dunes), the two latter so abundant as to form carpets. Next appear *Gamolepis ericoides* (limestone hills only), *Disparago Kraussii* (limestone hills only), *D. lasiocarpa* (limestone hills chiefly), *Cliffortia falcata*, *Agathosma dielsiana* (limestone hills), *A. Muirii* (limestone hills and sandy flats), *Stoebe phlaccoides* (limestone hills only), *Cluytia polifolia*, *C. rubricaulis*, *Metalsia* spp. It is the only locality known at present for *Relbania Steyniae* and *Euryops Muirii*, two composites with yellow flowers and ericoid leaves which grow with *Cotyledon Bolusii* on the almost bare rocky summits. *Mesembrianthemum calcicolum* is confined to this region, but *Sclago scabrida* occurs on the sandy flats as well. The vegetation is thinly scattered, consisting of shrubs about one to two feet high, among which *Passerina Galpini* is most abundant, with small clumps of taller shrubs ranging in height from six to eight feet. Among the latter *Gymnosporia laurina* is dominant. *Rhus glauca* and *R. lucida* grow here sheltering *Knorrtonia rigida* and *Astephanus neglectus*. Other common shrubs and sub-shrubs are *Muraltia Heisteria*, *M. satureoides*,



*M. longicuspis*, *Helichrysum teretifolium*, *Sutera stenophylla*, *Lotononis umbellata*, *Bouchea cernua*, and *Pelargonium betulinum*. Prominent herbs are *Heliphila pilosa* and *Zaluzianskya capensis*. The following occur among succulents:—*Mesembrianthemum Muirii*, *M. aurantiacum*, and *Othonna digitata*: among Monocotyledons *Cyrtanthus angustifolius* (limestone hills only), *Haemanthus coccineus*, and *Ianthe flaccida*. *Scilla lanceacifolia*, *Lachenalia lanceacifolia* and *Oterach cordata* grow in fissures and eroded holes. The *Restionaceae* on these hills, besides *Dovea microcarpa* already mentioned, are *Thamnochortus insignis*, *Leptocarpus vimineus*, *Restio Eleocharis* and *R. leptoclados*.

As yet there are no *Proteaceae*, but after passing a lime-burning station a mile further on, the first representative is seen on the next ridge, viz., *Leucadendron Muirii*, a shrub six feet high with dark green leaves. On neighbouring ridges showing up silvery yellow is *Leucadendron uliginosum*, a shrub which grows up to twelve feet; and at no great distance *Protea obtusifolia*, a shrub up to ten feet with dark green leaves five inches long and one and a half inches broad, and white or red flowers. All have hard leaves with thick epidermis. These three are closely associated on most of the limestone hills between Melkhoutfontein and Duivenhoeks River, Hoogekraal and Gouritz River, except *Leucadendron Muirii*, which does not grow much further east. The first and last named do not grow on the sandy flats, or at least extremely rarely, and *Leucadendron uliginosum* is so characteristic of the ridges that it is known as "koppiestolbos"). The leaves of *Leucadendron Muirii* are from two-fifths to one and one-fifth inches long and one-fourth to one-half inches broad; those of *L. uliginosum* one inch and a half long by a quarter broad. The former is known only from here, and *Protea obtusifolia* is one of the rarest of the genus in South Africa. On some hills the latter is dominant, on others *Leucadendron Muirii*. With these are many shrubs but only two trees; both xerophytic types, viz., *Sideroxylon incrne*, which in the inland Strandveld is more partial to the rocky ridges than to the sandy flats, and *Acacia cyclopis* from Australia, which occurs on the sandy flats as well. In the taller shrub layer occur *Olea verrucosa*, *Rhus glauca*, and *R. lucida* in great abundance (but not *R. crenata*), *Royena pubescens*, *Osyris abyssinica*, and *Gymnosporia burifolia*. Smaller shrubs are represented by *Erica spectabilis*, which is again plentiful here, *Indigofera brachystachya* in a variety peculiar to this region, *Cullumia setosa*, *Oedera latifolia*, *Othonna parvifolia*, *Walafrida cinerea*, *Thesium strictum*, *Euphorbia artifolia* (only locality known as yet), *E. Muirii* (limestone hills, sandy flats and dunes), and in places where sand has collected on the rocks *Erica arenaria* for which this is also the sole locality. There are no *Alocs*, *Acacia karoo*, nor *Elytropappus rhinocerotis* here. A rare and beautiful heath *Erica Mariae* finds here its only home in South Africa, and it is the sole locality for Riversdale for *Euchaetis uniflora*. The region is rich in *Rutaceae* such as *Diosma vulgaris*, *D. n. sp.* Muir 410 (limestone hills only), *Acmadenia densifolia*, and species of *Agathosma*. A few other shrubs growing here may be mentioned, viz.:—*Mundia spinosa*, *Aspalathus adelphæa* (limestone hills and sandy flats), and *Erioccephalus umbellatus*; and a few petaloid Monocotyledons besides those already recorded, *Satyrion coriifolium*, *Bobartia robusta*, *Forbesia plicata* and *Buphane disticha*.

Occasionally on the flats, as at Droogevlakte, the limestone assumes a flat table-like form ringing hollow when struck, and somewhat reminiscent of limestone "pavements." In the broad fissures and gaps in this are found *Ceterach cordata*, *Geranium ineanum*, and *Mesembrianthemum edule*. In wells in the limestone *Adiantum Capillus-Veneris* grows luxuriantly.

As the flora of the Recent Limestone is little known, a list of representative plants of other Families and Genera is given in addition to those already noted:—

- Cyperaceae: *Eriinia truncata* (limestone hills chiefly), *F. prae-morsa* (limestone hills), *Tetraria cuspidata*.  
 Liliaceae: *Kniphofia* sp., Muir 199.  
 Iridaceae: *Iris flexuosa*.  
 Amaryllidaceae: *Haemanthus coccineus*.  
 Orchidaceae: *Satyrium ligulatum*, *Ommatodium Volucris*, *Pterygodium cafferum*, *Corycina crispum*, *Disperis capensis*.  
 Urticaceae: *Australina capensis*.  
 Proteaceae: *Leucospermum attenuatum* (rarely, commoner on the sandy flats). No species here has pinoid leaves as is the case in the Langebergen.  
 Aizoaceae: *Mesembrianthemum litorale* (also on dunes, rocks near sea and sandy flats), *M. intermedium*, *Aizoon rigidum*.  
 Caryophyllaceae: *Dianthus scaber*.  
 Cruciferae: *Heliophila* spp.  
 Leguminosae: *Lotononis* spp., *Aspalathus* spp.  
 Zygophyllaceae: *Zygophyllum fulvum*.  
 Polygalaceae: *Polygala ericaefolia*, *P. pubiflora*, *Muraltia alopecuroides*.  
 Sterculiaceae: *Hermannia ternifolia* (rare, on limestone hills only), *H. trifoliata* (limestone hills only) and at least five other species of this genus.  
 Thymelaeaceae: *Struthiola rigida* (also common on the sandy flats), *S. Galpini*, *S. ericoides*, *Gnidia tomentosa*, *Lasio-siphon anthylloides*, *Passerina* spp.  
 Ericaceae: *Erica curtophylla* (limestone hills only), *Thoracosperma Muirii* (recently found on limestone hills only).  
 Gentianaceae: *Schaca aurea*, *Chironia scabrida*.  
 Borraginaceae: *Anchusa riparia*, *Lobostemon fruticosus*, *L. diversifolius*.  
 Verbenaceae: *Lantana salicifolia*, *Bouchea cernua* (also on sandy flats).  
 Labiatae: *Leonitis leonurus*, *Salvia aurea* (also on sandy flats).  
 Selaginaceae: *Selago* sp. Muir 1600.  
 Scrophulariaceae: *Sutera microphylla* (limestone hills only), *S. stenophylla*, *Zaluzianskya* spp.  
 Campanulaceae: *Lobelia capillifolia*, *L. tomentosa*, *L. coronopifolia*, *L. n. sp.* Muir 133 (an undescribed very remarkable species called the "tree lobelia," only locality), *Lightfootia ciliata*, *Cyphia digitata*.

Compositae: *Aster filifolius*, *Pteronia incana*, *Ursinia ciliaris* (rare, limestone hills only), *Eriocephalus* spp., *Helichrysum ericaefolium*, *H. chlorochrysum* (limestone hills only), *H. parriflorum*, *H. maritimum*, *H. cymosum*, *Helipterum argyropsis*, *Gnaphalium undulatum*, *Metalasia* spp., *Disparago* spp., *Relbunium squarrosa*, *Cineraria alchemiloides*, *Senecio juniperinus* (also on the sandy flats), *S. arnicaeflorus*, *S. paniculatus*, *Euryops virgineus*, *Berthecia coriacea*.

The vegetation on the limestone ridges includes therefore a number of species of great rarity, some only known to occur there up to the present. When explored they proved to be a treasure house of new or little known species. Others are confined to this region as far as the Riversdale Division is concerned, although known in other parts of the country. The vegetation is sclerophyllous in type with *Ericaceae*, *Proteaceae*, *Restionaceae*, *Rutaceae*, *Campanulaceae* and *Compositae* as the most important families. Many of the genera represented have small and narrow or ericoid leaves.

(b) The Sandy Flats and Low Sandy Hills.—The sandy flats are in some cases many square miles in extent and are everywhere fixed except where ox-waggon traffic, or the wind acting on areas denuded by veld fires, has set them moving. The grey limestone ridges enclose them, the dark green of *Sideroxylon inerme* and the silvery yellow of *Leucadendron uliginosum* showing up against them. In places it is trackless and impassable except on horseback or on foot. A mole, *Bathergus suillus*, as large as a rabbit, plays a part in digging over and disturbing the soil, and makes horseback riding dangerous to the stranger. It is a rodent and lives on bulbs and tubers, and has no connection with the insectivorous Golden Moles. At Droogevlakte the limestone is often only two or three feet below the covering layer of sand. In parts there are immense areas of *Thamnochortus insignis*, or "Dek-riet," six to seven feet high, the stems paler below, the inflorescence brown above, each stool a foot or more in diameter. The horseman or pedestrian in the early morning is soaked in dew when he pushes past them. Growing between them are the two commonest *Proteaceae* on the sandy flats, *Protea Susannae* and *Leucadendron Galpinii*, which with *Leucadendron adscendens*, *L. eucalyptifolium*, *Leucospermum Muirii*, *L. attenuatum* and *Protea mellifera* constitute the layer of tall shrubs. *Acacia cyclops*, an Australian species, has become dominant in many places, ousting the native species, and greatly diminishing the value of several farms. *Acacia karoo* is absent. A beautiful and striking inhabitant is *Gladiolus Bolusii* variety *Burchellii*, which is also found in the Langebergen, but is more abundant here. *Herschelia lugens* is found in the centre of *Restiad* clumps, almost concealed. There is a ground flora comprising many species occupying the intervening open spaces, such as *Oxalis* spp., *Arctopus echinatus*, *Cryptostemma calandulaceum*, *Massonia candida*, many annual *Scrophulariaceae*, *Conicosia Muirii* and *Mesembrianthemum criniflorum*.

In other portions of the sandy flats the *Restionaceae*, although everywhere a feature, are scattered thinly. The most remarkable is *Willdenovia argentea*, or "Olifants Riet," which is eight to ten feet high. The same *Proteaceae* are found here also. Another very

typical and important family of this region is *Ericaceae*, represented by *Erica versicolor*, *E. imbricata*, *E. speciosa*, *E. curviflora* (in places slightly damp), *E. cerinthoides*, *E. decipiens* (growing socially in fairly large areas), and *E. pulchella*. These are abundant, and near Albertinia *E. bowteana*, in both white and pink forms, is endemic and confined to a few farms only. About the end of December *Syndesmanthus viscosus*, and *Blaeria ericaides* appear in flower over large tracts, and in their seasons *Simocheilus dispar*, *S. depressus* and *Syndesmanthus scaber*. Two other small shrubs are noteworthy, namely *Staavia radiata*, which often gives a general greyish hue to the veld, and *Cliffortia ilicifolia*, both being widely spread and very plentiful.

*Leucospermum attenuatum*, which is in many places dominant, produces immense red and yellow sheets of colour in the landscape, and occurs with the less showy *L. Muirii*. There is one large area covered with *Aulax encorifolia*. *Leucadendron tortum* is locally abundant at Jakkalsfontein.

Other common shrubs are *Amphithalea ericaefolia*, *Polygala peduncularis*, *P. myrtifolia*, *Rhus lucida*, *Othonna parviflora*, *Osteospermum montiferum*, *Enclea undulata*, and *Pterocelastrus variabilis*. *Bobartia robusta* with large yellow flowers grows plentifully.

A detailed list of other families, genera, and species is given herewith, although not exhaustive:—

Filices: *Asplenium solidum*, *Pteridium aquilinum* (growing socially in a few localities in clearings and open places), *Schizaea pectinata*.

Cyperaceae: *Scirpus antarcticus*, *Ficinia paradoxa*, *F. setiformis* (damp places), *Fuirena hirta* (damp places), but this family is not prominently represented here.

Gramineae: *Cynodon Dactylon*, *Stenotaphrum glabrum*, *Pentstemon Thunbergii*, *P. angustifolia*, *Polypogon monspeliensis*, *Schismus fasciculatus*, *Ehrharta capensis*, *E. calycina*.

Restionaceae: *Restio Elcochoris*, *R. tetragonus*, *R. cuspidatus*, *Dorea tectorum*, *Elegia stipularis*, *E. Muirii*, *Thamnochortus Muirii*, *Staberoha distachya*.

Liliaceae: *Asparagus Kiansii* and other spp., *Anthericum* spp., *Lachenalia* spp., *Scilla Barberi*, *Ornithoglossum glaucum*.

Haemodorumaceae: *Wachendorfia paniculata*.

Amaryllidaceae: *Ianthé flaccida*, *Hessea filifolia*, *Haemanthus coccineus*, *Hypoxis* spp.

Iridaceae: *Moraea* spp., *Homeria* spp., *Ferraria undulata*, *Romulea* spp., *Aristea* spp., *Iris flexuosa*, *Hesperantha graminifolia*, *Geissorhiza Patersoniae*, *Lapeyrousia Fabricii*, *Ficesia refracta*, *Watsonia* spp., *Babiana* spp., *Tritonia squalida*, *Acidanthera tubulosa*, *A. capensis*, *Gladiolus* spp.

Orchidaceae: *Acrolophia tristis*, *Eulophia* spp., *Holothria villosa*, *Satyrium* spp., *Monadenia micrantha*, *Disa* spp., *Schizodium rigidum*, *Pterygodium catholiceum*, *Disperis villosa*.

Proteaceae: *Protea lanceolata*, *P. calacephala*, *P. decurrens*. The genera *Serruria*, *Vicinia*, and *Brabeium* are absent.

- Polygonaceae: *Rumex* spp.  
 Cytinaceae: *Cytinus dioicus*.  
 Aizoaceae: *Mesembrianthemum* (many species), *Pharnaceum* spp., *Galenia humifusa*.  
 Ranunculaceae: *Knowltonia rigida*.  
 Cruciferae: *Heliophila* spp.  
 Crassulaceae: *Crassula expansa*, *C. nudicaulis*. Not well represented on the sandy flats.  
 Bruniaceae: *Berzelia lanuginosa*, *Staavia radiata*.  
 Resedaceae: *Reseda Jacquinii*, an abundant ruderal of cultivation.  
 Rosaceae: *Cliffortia ilicifolia*.  
 Leguminosae: *Podalyria cuneifolia*, *Priestleya angustifolia*, *Rafnia triflora*, *Coelidium* sp., *Argyrolobium Muirii*, *A. stenorrhizon*, *Lebeckia* spp., *Wiborgia obeordata*, *Psoralea decumbens*, *Aspalathus dasantha*, *A. araneosa*, *A. callosa*, *A. remota*, *A. ciliatistyla*, *A. quadrata* (and other species of *Aspalathus*, some being new and only found here), *Indigofera heterophylla*, *Tephrosia capensis*, *Rhynchosia ferulaefolia*, *R. caribaea*, *Lotononis* spp.  
 Geraniaceae: *Pelargonium peltatum*, *P. lobatum*, *P. capitatum*, *Geranium incanum*.  
 Oxalidaceae: *Oxalis polyphylla*, *O. Mundii*, *O. polytricha*, *O. balsamifera*, *O. obtusa*.  
 Rutaceae: *Euchaetis Burchellii*, *Agathosma virgata*, *A. Muirii*, *A. riversdalensis*, *A. scaberula*, *A. serpyllacea*, *A. ericoides*. Several of these are confined to this region and were first discovered here.  
 Polygalaceae: *Polygala oppositifolia*, *P. myrtifolia*, *P. peduncularis*, *Muraltia stipulacea*. Poorly represented.  
 Euphorbiaceae: *Cluytia ericoides*, *C. polifolia*, *C. daphnoides*. Poorly represented in the sandy flats.  
 Rhamnaceae: *Phylica stipularis*, *P. parviflora*, *P. axillaris*.  
 Anacardiaceae: *Rhus* spp.  
 Sterculiaceae: *Hermannia* n. sp. Muir 1882, *H. scabra*, *H. decumbens*. Poorly represented.  
 Vitaceae: *Rhoicissus Thunbergii*.  
 Penaeaceae: *Penaea mucronata*.  
 Thymelaeaceae: *Passerina* spp., *Struthiola rigida*, *Gnidia tenella*, *Lachnaca axillaris*.  
 Malvaceae: No typical native representative.  
 Umbelliferae: *Carum hispidum*, *Arctopus echinatus*, *Bupleurum difforme*, *Annesorhiza* spp.  
 Ebenaceae: *Royena pubescens*, *Euclea undulata*.  
 Oleaceae: *Olea verrucosa*, *O. erasperata*.  
 Gentianaceae: *Sebacia albens*, *S. minutiflora*, *Chironia melampyrifolia*, *C. baccifera*.  
 Asclepiadaceae: *Microlooma tenuifolium*, *M. sagittatum*, *Cynanchum africanum*.  
 Convolvulaceae: *Convolvulus farinosus*.  
 Labiatae: *Salvia aurea*.  
 Solanaceae: *Solanum* spp.  
 Selaginaceae: *Hebenstreitia* spp., *Dischisma ciliatum*, *Selago spuria*. Poorly represented.

Scrophulariaceae: *Diascia* spp., *Hemimeris* spp., *Nemesia versicolor* (in several colour forms), and other spp., *Sutera* spp., *Phyllopodium* spp., *Polycarena capillaris*, *Zaluzianskya divaricata*, *Z. capensis*, *Harveya purpurea*, *H. capensis*, *Hyobanche sanguinea*.

Campanulaceae: *Wahlenbergia capensis*, *W. arenaria*.

Compositae: *Corymbium nervosum*, *Aster* spp., *Ursinia* spp., *Cotula sororia*, *Leontonyx spathulatus*, *Helichrysum* spp., *Amellus strigosus*, *Eriocephalus umbellulatus*, *Helipterum canescens*, *Metalsia muricata*, *Disparago Kraussii*, *Stoebe nervigera*, *S. sphaerocephala*, *Ifloga reflexa*, *Relbunium* spp., *Othonna* spp., *Gymnodiscus capillaris*, *Senecio* (many species), *Dimorphotheca pluvialis*, *Osteospermum moniliferum*, *Arctotis bellidifolia*, *Gerbera ferruginea*, and others.

The vegetation of the sandy flats is more copious in species than that of the recent limestone, and *Proteaceae*, *Eriaceae*, *Leguminosae*, and *Restionaceae* are better represented. The general type of a prevailing sclerophyllous vegetation remains the same, and the differences are chiefly in the direction of species.

#### *Plant Migration in the Strandveld.*

Very few subtropical or tropical types have up to the present penetrated into this low-lying coast belt in these southern latitudes. The tropical families *Sapindaceae*, *Moraceae*, *Malpighiaceae*, *Scitamineae*, *Dioscoraceae*, and *Flacourtiaceae* are unrepresented. *Euphorbiaceae* has four species of *Euphorbia*, and about five of *Clusia*. *Acanthaceae* is represented by a species of *Hypoestes*; *Menispermaceae* by *Antizoma capensis* only; *Amarantaceae* by one or two ruderal species of *Amaranthus*; *Apocynaceae* by *Carissa* *Ardurina*; *Rubiaceae* by *Galium tomentosum* and one species of *Rubia*; and *Cucurbitaceae* by two species of *Kedrostis* and one of *Melothria* at most.

### **(3) The River Valleys of the Strandveld.**

The vegetation of these valleys differs from that of the surrounding Strandveld in being, as might be expected, a form of river scrub. The river beds and shores consist of Bokkeveld shales exposed by the action of water. The vegetation has a close affinity to that of the Renosterveld, and not of the Strandveld. The distance from the waters edge to the border of the sand or limestone on each bank varies from fifty to two hundred yards. Where roads have been cut through the river slopes shales are exposed below, and limestone or sand above. The shales are removed in large pieces for making floors in outhouses and for stoeps.

#### *(a) Kaffr Kuis River at Melkhoutfontein on the Shales.*

The banks are clothed in a dark green mass of vegetation with *Sideroxylon inerme* the most prominent tree. *Schotia speciosa*, with dark red flowers and scanty foliage, is also plentiful. *Aloe arborescens* grows here in abundance, but neither this nor the *Schotia* occurs in the adjoining Strandveld. The principal tall shrubs are *Rhus longispina*, *Tarchonanthus camphoratus*, *Cassine kraussiana*, *Putterlickia pyracantha*, *Gymnosporia buxifolia*, *Chilianthus arboreus*, *Clauseria inaequalis* and *Olea verrucosa*. Smaller shrubs are *Gnidia*

*polystachya*, *Polygala myrtifolia*, *Azima tetracantha*, *Cluytia daphnoides*, *Rhus mucronata*, *R. glauca*, *R. lucida*, *Pteronia incana*. Scandent species here are *Cynanchum obtusifolium*, *Solanum geniculatum*, *Sarcostemma viminalis*, *Corydalis vesicaria*, *Pelargonium petatum*, and various species of *Asparagus*. Succulent plants are represented by *Cotyledon orbiculata*, *Crassula lactea*, *Aloe saponaria*, and in more open places by *Mesembrianthemum Muirii* and *M. edule*. On a rocky bluff *Aloe lineata* and *Euphorbia cereiformis* grow together in clumps. Where the banks spread out less steeply *Brunsvigia gigantea* occurs in sand on the right bank, and *Ecklonia glabra* a geophyte with underground storage organs weighing up to 140 pounds on the left. On an alluvial patch *Pteronia uncinata* grows socially and is rare, with *Athanasia filiformis* near it. The ground flora consists of *Ehrharta* spp., *Hypochaeris aristata*, *Senecio glutinosus*, *Cotula sororia*, *Stachys aethiopica*, *Cineraria geifolia* and other plants. The vegetation of the river banks here is similar to that found in the Renosterveld, the *Aloe* scrub, and in the valleys among the hills near Riversdale.

(b) *Alluvial Area at Elberts Kraal.*

This is a very fertile level area traversed by the Gouritz River, and is subject to occasional inundations. The soil is at least twenty feet deep, and consists of silt carried down from Oudtshoorn and the Klein Karoo by the Olifant and Gamka Rivers, and subsequently by the Gouritz River. *Acacia karoo* is here abundant, growing in a park like manner, although absent from the area just described. The dominant shrub is, or was, *Zygophyllum Morgana*, but it has now been cleared away by the owners. *Melanthus comosus* forms here small thickets. *Nicotiana glauca* shoots up plentifully after floods but soon dies down. *Cynanchum obtusifolium* covers *Azima tetracantha*, and converts brush-wood fences into masses of green. *Homeria lilacina* is abundant in grassy places, and annual *Scrophulariaceae*, *Sebaea scabra*, and a few ruderal plants, chiefly grasses, constitute most of the ground flora.

Proceeding northwards from the Strandveld *Rehmannia genistae-folia* appears. *Proteaceae*, *Ericaceae* and *Restionaceae* gradually get scarcer until no longer seen, and *Sideroxylon inerme* almost entirely disappears. A few shrubs of *Elytropappus rhinocerotis* show themselves, and after descending the last limestone ridge the Renosterveld is entered. The change from the varied vegetation of the Strandveld to the monotony of this new region is very striking, and floristically the boundary is well marked.

## II. THE VEGETATION OF THE RENOSTERVELD.

This is a *sclerophyllous* type with *Elytropappus rhinocerotis*, a *xerophytic* or at least *xeromorphic* shrub with leath-like leaves, belonging to *Compositae*, dominant. It covers thousands of square miles in the South Western districts, and some hundreds in Riversdale, where its distribution corresponds on the whole closely with the areas occupied by the Uitenhage, Witteberg and Bokkeveld Series. It is the chief shrub in these areas both where the soil is proper to the underlying rocks and where it is not. Climatic conditions are the same over the three areas.

*Elytropappus rhinocerotis* has not yet in the Riversdale Division succeeded in invading the Table Mountain Series to any great extent. Climatic and edaphic conditions are there different, but it is steadily beginning to occupy the lower slopes in places, and is found in the Heathland although not extensively. Higher up the mountains it is found near roads in the mountain passes, due to sheep and cattle conveying the germules on their wool and feet; to transport riders carrying bundles of it for the camp fire; and to its use as a packing for goods on ox waggons. Dr. K. H. Barnard first mentioned that there is sometimes a line of demarcation between the characteristic vegetation of this Renosterbos region and that on the Table Mountain Series, and instanced places on the south side of the Rivier Zonder End Mountains (Letter 12 August, 1925). Dr. S. H. Haughton has observed the same in the Ceres Division east of Ceres, and also to the north of the Matroosberg in the Hex River range. The Renosterbos grows also in the Klein Karoo but not so extensively as south of the Langeberg. The invasion from the northern or Klein Karoo side of the Langebergen is greater and more successful than from the southern side, and on the Aasvogelberg near Albertinia it is well-marked.

The Renosterveld finds its greatest development in the Bokkeveld Series area. This series in the Riversdale Division receives very much less rain than the Langebergen, although in Knysna, according to Dr. J. F. V. Phillips, the rainfall is the same in the Bokkeveld and on the Table Mountain Series. (Letter 1925.)

The moisture content of the soils of the Bokkeveld beds is much less than that of the Table Mountain beds. The shales of the former are tilted, and the open character and steep dip afford conditions for drainage which may have resulted here in the production of a drier type of vegetation. The Renosterveld is the driest, the Langebergen the dampest, and the Strandveld intermediate as regards holard in the Riversdale Division. During droughts the Renosterveld, especially in the area corresponding to the Bokkeveld beds, dries up, first, and farmers have to seek other pastures for their stock. This is one of the reasons why farming in this region is often difficult unless landowners have additional farms in the Strandveld or near the base of the Langebergen.

For more than one hundred years it has been known in Riversdale that the spread of the Renosterbos is due to the agency of man, who is the important biotic factor. Sparrman in 1775 wrote as follows regarding this very region ("Voyage to the Cape of Good Hope," Vol. I. pp. 250-254. London, 1785):—

"The rhinoceros bush, a dry shrub, which is otherwise used to thrive in barren tracks of land, now begins to encroach more and more on such places as have been thoroughly cleared and cultivated. When I asked the country people the reason of this, they would lay the blame on their sins." These sins he goes on to say are overstocking and under manuring, the cattle eating out the grass and herbs and leaving the Renosterbos. He concludes, "It is said that a farmer once attempted to destroy and extirpate all the rhinoceros bushes on his lands by fire, but that they afterwards grew up again more vigorous than ever, so that, as well with respect to the effects



of the industry of man as to the more immediate operations of nature, it is not at all unlikely that future ages may see this part of Africa entirely changed and different from what it is at present."

Burchell (1814), Backhouse (1838), and Bunbury (1838) also mention its prevalence here. Barrow (1797), Lichtenstein (1803), and Latrobe (1816) describe this part of the country as dull and uninteresting, an appearance chiefly due to this shrub. It is therefore an invader, and an alien to the region, depending for its success on destruction of the vegetation by fire, overstocking and ruthless exploitation. It extends through different climatic areas, and is, as Professor Bews says a "rather plastic pioneer type, appearing often as a ruderal or as Clements puts in 'subseres,' which are the result of man's interference." (In litt.)

The presence of the Renosterbos, when not in the mountains, is regarded by the farmer as an indicator of "Soet Veld," in contradistinction to the "Suur Veld" of the Langebergen, terms, however, having no reference to the chemical reaction of the soil. Dwellers in the Klein Karoo still refer to the region south of the range as "Gras veld," an old term which has survived and is perhaps more applicable to a state of affairs that has long passed away. It is the chief sheep-farming area, as well as the principal *Aloe ferox* one. Indeed Aloes extract was first exported from South Africa in 1761 and came from this division. It is the "Drooge Ruggens" region of Barrow. (Travels 4<sup>to</sup> 1801). Although at first sight desolate and apparently bearing few other shrubs and plants, closer inspection reveals a copious and diversified vegetation. Wheat is cultivated fairly extensively by "dry land farming."

The Renosterveld may be divided into the Renosterveld area proper and the xerophytic Aloe Scrub. During winter the darker areas of the latter are lit up by red flowers of the aloes, visible in mass at long distances.

#### (a) The Renosterveld Area proper.

The vegetation will first of all be considered generally, without any attempt to make any correlation between it and the soils, as this is rarely possible with safety. In a typical locality the Renosterbos is dominant and from three to six feet in height. *Relbunium genistaefolia* is often sub-dominant, although in other places it may not be abundant. Here and there are small shrubs of *Rhus lucida*, *Selago corymbosa*, *Walafrida ciliata*, *Pelargonium Rustii*, *Aspalathus microdon*, *A. spinosa*, *Blepharis capensis*, *Heterolepis penduncularis*, *Pteronia hirsuta*, *P. incana*, *Pentzia flabelliformis*, *Chrysocoma tenuifolia*, *Crassula ericoides*, *C. sphaeritis*, *C. ciliata* and *C. acutifolia*. At one place there is a patch of the very rare *Argyrolobium connatum* with silky canescence. *Cynodon Dactylon* is the dominant grass in some localities, and in others *Themeda Forskalii*. Other shrubs are *Osteospermum polygaloides*, *Sutera caerulea*, *Royena pubescens*, *Lycium Kraussii*, *Mesembrianthemum rigidum*, and *M. parvifolium*, but there is an absence of *Proteaceae*, *Restionaceae* and *Ericaceae*. There are no trees outside the Aloe scrub, except an occasional *Sideroxylon inerme* and *Acacia cyclops*. A few examples of *Aloe ferox*, however, may be scattered here and there and growing alone. *Cuscuta africana* and *C. appendiculata* are common, matting

*Elytropappus rhinocerotis*, *Hermannia ovalis* and *Selago corymbosa* together, especially in places burnt off eighteen months earlier. *Microlooma tenuifolium* and *Cyphia campestris* are frequent scandent species.

The following Monocotyledons are common and resist fire, viz.: *Cyanella capensis*, *C. lutea*, *Hypoxis floccosa*, *Drimia elata*, *Bulbine asphodeloides*, *Urginea altissima* a geophyte with an enormous bulb and sometimes bearing 500 to 800 flowers, and *Hesperantha lutea*.

There is a rich ground flora as the shade is never very dense. Lichens grow directly on the clayey soil and *Lecanora cinnabariza* on the stones. Xerophytic types of *Bryophyta* such as *Tortula pilifera* and *Triquetrella tristicha* are proofs of the dry nature of the region. Many annuals and perennials occur here such as *Cotula sororia*, *Relbunium sessiliflorum*, *Pharnacanthus incanum*, *P. dichotomum*, *Amellus strigosus*, *Diascia Burchellii*, *D. sacculata*, *Sutera antirrhinoides*, etc. The detailed list here given shows other associated plants but is representative only:—

Filices: *Mohria caffrorum*, *Cheilanthes multifida*, *C. hirta*, *Pellaea hastata*, *P. auriculata*, *Adiantopsis capensis*, *Asplenium adiantum-nigrum*. Most of these are in stony places in partial shade.

Gramineae: More or less common are *Lasiochloa ciliaris*, *Tragus koelerioides*, *Digitaria eriantha*, *Cynodon Dactylon*, *Andropogon contortus*, *Panicum serratum*, *Setaria flabellata*, *Koeleria cristata*, *Arcuistrum caffrum*, *Pentstemon curvifolius*, *P. angustifolius*, *Polypogon monspeliensis*, *Danthonia curra*, *Eragrostis brizoides*, *Chloris petraea*, *Ehrharta* spp., *Melica racemosa*, *Lasiochloa longifolia*, *Festuca scabra*, and *Brizopyrum capense*.

Cyperaceae: *Picinia gracilis*, *P. bulbosa*, *P. tristachya*.

Commelinaceae: *Cyanotis nodiflora*, *Commelina africana*.

Liliaceae: *Asparagus* spp., *Aloe saponaria*, *A. ferax*, *Bulbine caudata*, *Bulbine* spp., *Massonia candida*, *Polygala pygmaea*, *Lachenalia* spp., *Massonia candida*, *Dipcadi hyacinthoides*, *Albuca* spp., *Ornithogalum* spp., *Androcymbium longipes*, *Wurmbea capensis*, *Bacometra columellaris*, *Drimia elata*.

Haemodoraceae: *Cyanella capensis*, *C. lutea*.

Amoryllidaceae: *Forbesia plicata*, *Ianthia orata*, *Hypoxis* spp., *Hesperantha lutea*, *Carpolyza spiralis*, *Gethyllis villosa*, *G. afra*, *G. spiralis*, *Haemanthus rotundifolius*, *Buphane ciliaris*, *Pauridia hypoxioides*.

Iridaceae: *Moraea* (numerous spp.), *Homeria collina*, *H. ochroleuca*, *H. lilacina*, *Galaria orata*, *Hesperantha lutea* (very abundant), *Geissorhiza Patersoniae*, *Iris polystachya*, *Watsonia aletroides*, *Tritonia hyalina*, *T. deusta*, *Gladialis involutus*, *G. permeabilis*, *Antholyza Muirii*.

Orchidaceae: *Bartholina Ethelae*, *B. pectinata*, *Holothrix* spp., *Habenaria Bonatea*, *Disperis Bolusii*, *Corycium crispum*. This family is not well represented.

Santalaceae: *Thesium nigromontanum*, *T. Friscae*, *T. funale*; poorly represented.

- Aizoaceae: *Mesembrianthemum* (many species), *Pharnaccum incanum*, *P. dichotomum*, *Galenia humifusa*, *G. secunda*.  
 Hydnoraceae: *Hydnora africana*.  
 Portulacaceae: *Anacampseros rufescens*.  
 Caryophyllaceae: *Dianthus* spp., *Cerastium capense*, *Silene clandestina*.  
 Ranunculaceae: *Knorltonia hirsuta*.  
 Cruciferae: *Brachycarpaea laxa*, *Heliophila* spp.  
 Droseraceae: *Drosera pauciflora* (occurring even in fairly dry places).  
 Crassulaceae: *Crassula* (many spp.), *Kalanchoe rotundifolia*, *Cotyledon orbiculata*, *C. paniculata*. Well represented.  
 Leguminosae: *Lotononis umbellata*, *Argyrobolium pumilum*, *A. connatum*, *Wiborgia tetraptera*, *Aspalathus* (many spp.), *Indigofera* spp., *Sutherlandia frutescens*, and *Lesseria stenoloba*. In this family *Aspalathus spinosa* and *Indigofera denudata* have thorns.  
 Geraniaceae: *Pelargonium* spp., *Erodium cicutarium*.  
 Oxalidaceae: *Oxalis* (numerous spp.)  
 Polygalaceae: *Polygala oppositifolia*, *P. myrtifolia*, *Muraltia trinervia*, *M. ononidifolia*.  
 Euphorbiaceae: *Euphorbia* (at least ten spp.), *Cluytia pubescens*, *Adenocline sessilifolia*. Rather well represented.  
 Rhamnaceae: *Phylica* spp., *Rhamnus prinoides*.  
 Malvaceae: *Hibiscus pusillus*, *H. aethiopicus*.  
 Sterculiaceae: *Hermannia ovalis*, *H. conglomerata* (and numerous other spp.)  
 Elatinaceae: *Bergia glomerata*.  
 Linaceae: *Linum africanum*.  
 Rutaceae: *Diosma vulgaris*, *Coleonema pulchrum*, *Barosma foetidissima*, *Agathosma cricoides*.  
 Anacardiaceae: *Rhus lucida* (and other spp.).  
 Araliaceae: *Cussonia spicata* (sometimes, but oftener in the *Aloe* scrub.)  
 Umbelliferae: *Carum capense*, *Rhyticarpus rugosus*, *Lichtensteinia interrupta*, and *Aretopus echinatus*.  
 Celastraceae: Occasional but commoner in the *Aloe* scrub.  
 Asclepiadaceae: *Microlooma tenuifolium*, *Stapelia variegata*, *Asclepias fruticosa*, *A. rotundifolia*, *Schizoglossum linifolium*, *Pachycarpus dealbatus*, and *Brachystelma Thunbergii*.  
 Ebenaceae: *Royena pubescens*, *R. glabra*, *Euclea undulata*.  
 Convolvulaceae: *Convolvulus filiformis*, *Cuscuta africana*, *C. appendiculata*, *Falkia repens*.  
 Boraginaceae: *Lobostemon* spp., *Echinospermum Lappula*.  
 Labiatae: *Salvia paniculata*, *S. runcinata*, *Teucrium africanum*.  
 Solanaceae: *Solanum* spp., *Lycium Kraussii*.  
 Selaginaceae: *Dischisma erinoides*, *Walafrida* spp., *Sclagocorymbosa*, *S. Thomii*, *S. spuria*.  
 Scrophulariaceae: *Diascia* spp., *Hemimeris montana*, *H. sabulosa*, *Nemesia Guthriei*, *Tecdia lucida*, *Freylinia undulata*, *Manulca Cheiranthus*, *M. parviflora*, *Sutera caerulea*, *S. antirrhinoides*, *S. polyantha*, *Phyllopodium diffusum*, *Polycarena capillaris*, *Hyobanche sanguinea*, *Zaluzianskya divaricata*, *Harveya capensis*.

Acanthaceae: *Blepharis capensis*, *B. molluginifolia*, *Barleria capensis*, *Justicia orchioides*, and *Ruellia Zeyheri*. Poorly represented.

Rubiaceae: *Plectronia ventosa*, *Galium capense*.

Dipsacaceae: *Scabiosa columbaria*.

Cucurbitaceae: *Citrullus vulgaris*, *Cucumis myriacantha*.

Campanulaceae: *Lightfootia* spp., *Cyphia campestris*, *Microcodon hispidulum*, *Wahlenbergia undulata*, *Monopsis tenella*.

Compositae: *Amellus strigosus*, *Pteronia hirsuta*, *Ursinia rigidula*, *U. annua*, *Matricaria Burchellii*, *Pentzia virgata*, *P. flabelliformis*, *Eriocephalus umbellulatus*, *Helichrysium* spp., *Athrixia capensis*, *Leyssera guaphaloides*, *Nestlera tenuifolia*, *Chrysocoma tenuifolia*, *Senecio* spp., *Tripteris glandulosa*, *Arctotis acaulis*, *Gorteria diffusa*, *Gazania pinnata*, *Chrysanthemum carnosulum*, *Berkheya carthamoides*, *Dicoma Burmanni*, *Lactuca capensis*, *Relbania genistaefolia* and *R. squarrosa*.

The three great geophytic families of Monocotyledons are well represented, as might be expected after centuries of veld burning both before and subsequent to the coming of Europeans. The succulent genera also show up strongly, so that the vegetation as a whole shows some affinity to that of the Karoo and to eastern types. There is no grassland.

Termite nests or "antheps" are common, and when ruinous are sometimes occupied by species of *Asparagus* and by *Aloe sapo-naria*, being often used as perches by fruit and seed-eating birds.

#### (b) **Aloe Scrub.**

This type of xerophytic scrub is now mostly confined to the hillslopes of the eastern half of the Division, and is being rapidly cleared away except on rocky ground, as the space occupied is more valuable for sheep farming than for the extract of aloes industry. The dry peduncles of *Aloe ferox* are often occupied by a boring solitary bee (*Xylocopa*). The flowers of *Aloes* and *Gasteria* are chiefly ornithophilous, and are visited in Riversdale by the Malachite Sunbird (*Nectarinia famosa*), the Lesser Double-collared Sunbird (*Cinnyris chalybeus*), the Orange-breasted Sunbird (*Anthobaphus violacea*) and the Weaver-bird (*Sitagra capensis*).

*Sideroxylon incrne* and *Cussonia spicata* are common trees in the scrub. When ground is cleared for cultivation they are almost invariably left to afford shade to the workers during harvest, and are often seen standing alone in the middle of a wheat field. They also, by design or otherwise, frequently escape veld fires, and remain behind when the fields are abandoned. In such areas the process of veld regeneration can therefore be observed. One of the first shrubs to appear, often at the base of these trees is some species of *Asparagus* such as *A. africanus* followed by *Rhus lucida* and *Carissa Arduina*. All these have fruits eaten by birds or bats which settle in the trees. *Aloe ferox* similarly often first of all stands alone in the veld. The seed is a favourite food of ostriches, and in the flourishing days of ostrich farming, the tapping of *Aloes* was forbidden by landowners to ensure a large supply of seed. It is probable that other birds eat

them as well. *Aloe ferox* has existed in countless numbers since the days at least of the first Europeans—*instar exercitus* as Thunberg finely says. (*Flora Capensis*, Stuttgart 1823.) Not only does a single *Aloe* act as a pioneer and centre, but the number of centres becomes indefinitely multiplied. The composition of the scrub is in its main features fairly uniform. *Aloe arborescens* is very abundant, and *A. salmdyckiana* is a third common species, although probably a hybrid between the other two. In some places, however, notably at Middeldrift and Zandfontein, the huge *A. speciosa* with pale flowers and tall forked stems is dominant. The layer of shrubs varying in height from eight to ten feet, consists of *Olea verrucosa*, *Euclea undulata*, *Carissa Arduina*, *Scutia Commersoni*, *Rhus lucida*, *R. longispina*, *Gymnosporia burifolia*, *G. laurina*, *Putterlickia pyracantha*, *Cluytia daphnoides*, *Lycium* spp., *Plectronia ventosa*, *Pterocelastrus variabilis*, *Grewia occidentalis*, and *Cassine kraussiana*. The spines of *Rhus longispina* sometimes make the scrub almost impenetrable, and *Asparagus* spp. bind the whole together. On the borders are found *Dodonaea thunbergiana*, *Royena pallens*, *R. glabra*, sometimes *Galenia africana*, *Cadaba juncea*, and *Malvastrum tridactylites*. Succulent plants present are *Cotyledon orbiculata*, *Euphorbia mauritanica*, *E. clandestina*, *Mesembrianthemum rigidum* and *Bulbine caulescens*. The scandent plants are *Asparagus capensis*, *A. africanus*, *A. Kraussii*, and *Sarcostemma viminalis*. The ground vegetation in the early stage consists chiefly of small plants of *Elytropappus rhinocerotis*, and herbs such as *Hemimeris* spp., *Diascia* spp., *Sutera antirrhinoides*, *Crassula sarifraga*, *Cineraria platycarpa*, *Oligocarpus calendulaceus*, *Cynodon Dactylon*, *Aira caryophylla* and *Lasiochloa ciliaris*. In the latter stages of the succession these are killed off by the increasing shade, excepting *Stipa dregeana*. A marked feature is the number of species mentioned which have thorns.

### (c) Vegetation and some Special Areas.

There are some areas in the Renosterveld which show certain differences from the preceding, or for other reasons deserve special notice.

#### I. Uitenhage Series.

1. The Basin or Valley.—This portion, so distinct topographically, is the home of intensive farming and is specially prosperous and fertile. Grain, fruit and vegetables are produced here. It is also from the scenic standpoint in marked contrast to the dull uniformity of the rest of the Renosterveld. English oaks, willows, poplars, firs and other conifers, *Eucalyptus globulus* and *E. cladocalyx* are introduced trees which thrive well, and show the influence of closer settlement. Many ruderals as *Roubieva multifida* and *Salvia iwaefolia*, *Artemisia afra*, *Athanasia linifolia* and *A. filiformis*, the composition of the former vegetation, but enough remains even there to show that *Elytropappus rhinocerotis* was dominant and *Relbaniagenistaefolia* sub-dominant. In other places this is more distinctly seen. Four shrubby *Compositae* occupy large tracks of country, which though dry in summer are somewhat humid in winter, viz.:—*Conyza iwaefolia*, *Artemisia afra*, *Athanasia linifolia* and *A. filiformis*, the two latter showing in mass great sheets of yellow flowers. Succulents are less common, and *Aloe ferox* has for the most part been

cleared away. *Orchidaceae* are more numerous than in the other portions of the Renosterveld. The valley contains most of the marshes in the Riversdale Division, and much of the vegetation of the meadows belongs to the zones of vlei grasses and hygrophilous trees and shrubs. In drier parts the prevalence of *Acacia karoo* is very striking, which with the continuous grassy sward (*Cynodon Dactylon* chiefly) produces on a limited scale a park-like aspect. These trees are from 12 to 20 feet high, and are aggregated in places to form a more or less open scrub. A few plants of *Aloe ferox* grow among them, and more abundantly on the rim of the basin. *Usnea barbata* hangs in festoons from *Acacia karoo*, which casts very little shade, so that grass grows up to the bases of the trunks. *Allium dieganum* and *Tulbaghia capensis*, both alliaceous, are abundant here. Many other Monocotyledons are found, viz.:—*Albuea altissima*, *Cyanella lutea*, *Moraea ciliata*, *Homeria miniata*, *Massonia candida*, *Carpolyza spiralis*, *Laehcnalia latifolia*, *Pauridia hyporidoides* and four species of *Bulbine*. *Cryptostemma calendulaceum*, *Senecio matricariaefolius*, *S. laevigatus*, and many small annual *Scrophulariaceae* grow here in spring, and *Corydalis craeca* clammers freely. No correlation of the vegetation with soils is attempted here.

2. *Vegetation of Hills in Relation to Geology.*—The upper portions and summits of the hills of the Uitenhage Series show crumbling conglomerate, either in the form of rock or in lumps lying about on the mudstone, sands, and clays. Such areas at Spiegels River were chosen as were without foreign deposits. The renosterbos was dominant as elsewhere, other shrubs being *Rhus glauca*, *Euclea lanceolata*, *Chrysanthemum carnosulum*, *Metalasia muricata*, a species of deflorate *Passerina*, *Gnidia sericea*, *Arthrosolen inconspicuus*, *Selago corymbosa* and *Hermannia flauwea*. Monocotyledons here were *Urginea altissima*, *Bobartia spathacea*, and *Romulea bulbocodioides*; and *Cryptostemma calendulaceum*, *Oralis* spp., and *Cotula turbinata* some of the herbs. *Aloe ferox* and *A. arborescens* grew sparingly; and *Asparagus capensis* and *Acacia karoo* were the chief thorny species. More noteworthy were *Melanthus major*, *Leucadendron abietinum* (with pinoid leaves an inch long, abundant), and *L. adscendens* (with linear-oblongate leaves).

The *Ericaceae* comprised *Erica versicolor*, *E. cerinthoides*, *E. peltata*, *Blaueria pusilla*, and another belonging to a minor genus, deflorate.

Thus nothing definite could be deduced, and the *Ericaceae* may be overlaps from the Langebergen.

## II. *Vegetation of the Melilite Basalt.*

Such volcanic deposits are usually characterized by great sterility but this area has long lost any features of this nature. It is too small, too easily accessible to invaders from the surrounding conglomerates and clays, and showed no peculiar differences. Among the broken, grey black rocks were the ubiquitous *Elytropappus rhinocerotis*, *Royena pallens*, *Euclea lanceolata*, *Selago* sp., *Crassula ciliata*, *Chrysocoma tenuifolia*, *Cryptostemma calendulaceum* and *Helichrysium crispum*. *Bulbostylis humilis* was extremely abundant, growing socially and running together into green patches.

### III. Vegetation of Witteberg Series in Relation to Geology.

Viewed laterally this mass of sandstone and quartzite is wedge-shaped, its edge near the Vet River, and its base forming rocky bluffs looking towards the Bokkeveld Beds. Most of the area on the upper slopes, plateaux and summits shows exposed rock, with only a slight deposit of soil. Even on the lower slopes the soil is mostly only four to twelve inches deep. This may conceivably be assumed as having been produced by the Series, but the whole area is not extensive. Although too much stress is not laid on the connection, it is worthy of note that under identical climatic conditions the vegetation, even in this limited area, differs in certain respects from that in other portions of the Renosterveld, and includes a number of peculiar species.

One is the occurrence of *Proteaceae*. *Leucadendron adscendens* until a few years ago was plentiful here, and did not occur in the neighbourhood away from the area. It is now rare here, having been removed for firewood. On the upper slopes *Aloe arborescens*, *Carissa Arduina* and the usual species of the Renosterveld are seen, but do not at this place form as yet xerophytic scrub. The renosterbos is still dominant. A very rare shrub *Muraltia cliffortiaefolia* is plentiful, and also *M. Heisteria* and *M. ononidifolia*. *Aspalathus affinis* reaches here two to three feet in height. Succulent plants are plentiful and include *Euphorbia tridentata*, *E. aspericaulis*, *E. pugiformis*, *E. pistiaefolia*, *Pelargonium Rustii*, *Crassula cricoides*, *Cotyledon Bolusii*, and *Doria Gymnodiscus*. The following are found among rocks at the summit at 800 feet:—*Aloe ferox*, *A. arborescens*, *Plectronia ventosa*, *Grewia occidentalis*, *Teedia lucida*, *Diosma* sp., *Phylla* sp., *Asclepias rotundifolia*, *Cluytia rubricaulis*, *C. pubescens*, and *Rhus rosmarinifolia*. The Aloes combine with some of these, especially *Gymnosporia laurina* and *Rhus longispina* to form a succulent scrub of almost the same composition as that previously described. In shady places among the rocks are *Pellaea auriculata* and *Holothrix lindleyana*, and in cups in the rocks *Crassula punctulata* and *C. orbicularis*. On the gravelly and stony layer occur the very rare *Haworthia albicans* (the only Riversdale locality known), *H. retusa* and, chiefly in shade, *H. cuspidata* (also the only Riversdale locality as yet), *Aloe brevifolia*, *Ornithogalum subulatum*, *Crassula expansa* and *C. cultrata*. The presence of *Ericaceae*, *Restionaceae* and *Proteaceae* is, however, the most remarkable feature, as these do not usually occur in the Renosterveld except near the mountains. *Erica versicolor*, *E. cerinthoides* and *E. peltata* grow on the rocky bluffs or on the slopes. *Restio triflorus* and *Leptocarpus vimineus* also occur here. Besides *Leucadendron adscendens* already mentioned two other *Proteaceae* are found, namely *Leucadendron abietinum* and *Protea decurrens*, both growing semi-socially. This small, isolated Witteberg area has therefore a vegetation distinguished by the presence of three species of *Ericaceae*, three *Proteaceae*, all of a narrow-leaved type, and two *Restionaceae*; shrubby *Compositae*; many succulents, including rare *Euphorbias* and *Haworthias*, and several *Aloes*; and a few *Ebenaceae* and *Polygalaceae*. Dr. R. Markoth (Das Kapland, Jena, 1908) found a vegetation possessing features in the Wittebergen at Matjesfontein. Besides the shrubs mentioned above may be noted *Relbania cuneata*, *Stoebe cinerea*, *Oedera latifolia*, and *Guidia caniflora*; the following herbs *Ursinia annua*, *Tripteris tomentosa*, and

*Oxalis polyphylla*; the grasses *Cynodon Dactylon*, *Pentaschistis angustifolia*, *P. Thunbergii*, and *Lasiochloa ciliaris*; the *Cyperaceae* *Ericinia paradoxa*, *E. tristachya*, and *Schocuoxyphium Ecklonii*; the ferns *Pellaea hastata* and *Cheilanthes hirta* variety *contracta* among the rocks at the summit; the succulents *Crassula sphaeritis*, *Mesembrianthemum bellidiflorum*, *M. purpurca-album*, *M. edule*, and *Anacampseros rufescens*. The chief Monocotyledonous plants are *Scilla lanceaefolia*, *Albuca* spp., *Bulbine* spp., *Urginea altissima*, and *Lapeyrouisia fissifolia*.

#### IV. Vegetation of Bokkeveld Series in Relation to Geology.

There are large areas in the Renosterveld where the Bokkeveld shales are on the surface, and lie broken or are covered by one to three inches of soil. It is assumed that the soil in such large areas may be considered as proper to the rocks. Without trying to push the correlation too far, the vegetation is seen to me made up as follows:—

*Elytropappus rhinocerotis* is dominant, other very common shrubs being *Relbunium genistaefolia*, *Sclago corymbosa*, *Indigofera denudata*, variety *spinosa*, *Aspalathus microdon*, *Muraltia ononidifolia*, *Ruellia Zeyheri*, *Crassula sphaeritis*, *C. ericoides*, *Hibiscus pusillus*, and the grass *Themeda Forskalii*. There are thus no special features distinguishing this area from the rest of the Renosterveld.

#### Area of the Renosterveld Adjoining the Langebergen.

This area belongs to the Bokkeveld Series and is made up of hills with rocky summits and bluffs. Three species of *Leucadendron* are found here, *L. abietinum* (occurring very rarely or not at all on the Langebergen), *L. abscondens* (abundant on the Langebergen), and *L. coriaceum* (only locality in Riversdale). The last-named has leaves approaching the myrtiform type. *Erica peltata*, *E. cerinthoides*, *E. versicolor*, and *Leptocarpus rimineus* occur here again. Other species are *Phyllea velutina*, *Cliffortia octandra*, and *Argyrobolium pumilum*. *Elytropappus rhinocerotis* is dominant.

Some of the peculiarities of this portion may be due to its adjoining the Langebergen, which slope down to it.

#### (d) Ericaceae, Proteaceae, and Restionaceae in the Renosterveld.

It has sometimes been said that these three families do not occur between the Strandveld and the Langebergen, but this is not absolutely correct as a generalisation.

##### 1. Ericaceae.

*Erica peltata* occurs normally on the Witteberg Series, and overlaps the neighbouring portions of the Renosterveld. It is found, also, on the conglomerate and sands of the Uitenhage Series, where these are not far distant from the Langebergen: and also on the Bokkeveld Series in similar positions.

*Erica cruenta* is found rarely on the Bokkeveld shales in the beds of streams, probably brought down by the Valsch River and streamlets from the Langebergen.



*Erica racemosa* and *E. quadrangularis* occur on river banks, being probably spread in the same way. They are hygrophilous types, or at least are found frequently, although not invariably, in damp places.

## 2. *Proteaceae*.

*Brabeium stellatifolium* grows in the vleis at Wyders Rivier, and may have migrated along streams from the mountains, or have been brought down by them.

*Leucadendron abietinum* may be normal on the Witteberg Series, and is also found on them near Matjesfontein. It occurs on the strip adjoining the Langebergen as do *L. adscendens* and *L. coriaceum*.

*Protea decurrens* occurs normally on the Witteberg area.

## 3. *Restionaceae*.

*Restio triflorus* occur normally on the Witteberg Series.

*Leptocarpus vimineus* has a peculiar and extensive distribution in the Riversdale Division, as it occurs on the Witteberg Series, on the Renosterveld strip near the Langebergen, and on the Recent Limestone in the Strandveld. *Thamnochortus paniculatus*, *Hypodiscus alboaristatus* and *Elegia asperiflora* occur in vleis as, for example, those near the Vet River.

With these exceptions and possibly one or two others, the families mentioned are absent from the Renosterveld area.

## (e) **Vegetation of the River Valleys in the Renosterveld.**

This varies somewhat according to whether the banks of the rivers are high and rocky, or low and shelving.

### 1. *Where high and rocky.*

This is usually the case where the stream cuts through the Bokkeveld Series, exposing bare rocks of shales with clayey earth in the crevices. Many succulents grow here, viz., *Euphorbia cerciformis*, *Haworthia* spp., *Anacampseros Telephiastrum*, *Cotyledon Muirii*, *C. paniculata*, *Crassula lycopodioides*, *C. perfoassa*, *Gasteria verrucosa*, *Aloe arborescens*, *Mesembrianthemum Zeyheri*, *M. barbatum*, *Senecio ficoides*, *S. Muirii*, *Euryops spathaceus*. Where the banks are less steep trees and shrubs gain a footing such as *Cussonia spicata*, *Euclea undulata*, *Olea cerrucosa*, and *Opuntia marima* variety *spinosa*. Sometimes these form a river scrub, but more often they are scattered. Some Monocotyledons are found such as *Nerine humilis*, *Ornithogalum subulatum*, *O. pilosum*, and *O. caudatum*. *Andropogon hirtus* is very frequent in crevices and dry river beds.

### 2. *Where low and without rocks.*

*Acacia karoo* in the alluvial bends often occurs abundantly forming an open scrub, the trees standing a few yards apart with *Aloe ferox*, shrubs and scandent plants in the intervening areas. *Meliamthus comosus* is extremely frequent, with *Lycium arenicolum*, *Solanum pseudocapsicum*, *Noltea africana*, *Clilianthus arboreus*, *Rhamnus prinoides*, *Rhus lancea*, and *R. incana*. *Azima tetracantha* extends from the coast far up the river valleys. *Eragrostis spinosa*

is a noteworthy grass in the bed of the Gouritz River which consists here chiefly of silt brought down by the current. *Cotula villosa* and many ruderal plants are abundant.

The vegetation of the marshes which adjoin the Kafir Kuils River and Vet River is described in another section.

**(f) Plant Migration in the Gouritz River System.**

It has been mentioned that the rivers in the Riversdale Division, arising south of the Langebergen, have apparently brought down certain *Ericaceae* and other plants from the mountains to lower levels. On the banks and bed of the Gouritz River south of the mountains there is found a curious concentration of species which might not be expected in this region. A comparison of the geography of the whole Gouritz River system with the known geographical distribution of these plants suggests that some of them have been brought down by flood waters or migration from the north. Plant migration has also occurred in the reverse direction. In this animals such as antelopes and birds are also probably concerned.

1. Species with most distant distribution:—

- Eragrostis spinosa*: Ceres, Namaqualand and Clanwilliam.
- Sesamum capense*: Ladismith, Richmond and Central Karoo.
- Forskahleia candida*: Prince Albert.
- Watafrida paniculata*: Central Karoo.
- Anthospermum rigidum*: Namaqualand.
- Phyllopodium pumilum*: Little Namaqualand, Clanwilliam and near Albertinia in broad sandy valleys leading upwards from the Gouritz River.
- Albucca namaquensis*: Common between Riversdale and Albertinia and on hills near Gouritz River. Little Namaqualand.
- Euphorbia aspericaulis* (including *E. caterviflora*): Calvinia, Muraysburg, Beaufort West. In the Riversdale Division abundant on hills near the village and near Gouritz River.

Were the Central Karoo and other localities of these species more fully known the comparison might be even more striking. Their distribution in the Riversdale Division is in some cases very local.

2. Species occurring in the Klein Karoo:—

- Euphorbia mauritanica*: Although found elsewhere in the South-West it is extremely abundant in the Klein Karoo. South of the Langebergen it is extremely plentiful and concentrated on or near the shores of the Gouritz River and its tributaries.
- Melanthus comosus*: This is typical of the stream bank vegetation of the Klein Karoo, and it occurs chiefly along the Gouritz River when found south of the Langebergen.
- Galenia africana*: Common in the Klein Karoo, but south of the mountains chiefly in the Gouritz River system.
- Nymania capensis*: Common in the Klein Karoo, but south of the range only in the Gouritz River gorge.
- Lycium arnicolum*, *Eragrostis bergiana*, and *Mesembrianthemum juccinum* are, south of the Langebergen, only found in Riversdale about the Gouritz River.

## 3. Coast types:—

*Acrida tetracantha* is found abundantly on the coast, and extends up the river banks, notably those of the Gouritz River nearly to the Langebergen. So far as is known it does not grow far from the rivers.

*Zygophyllum Morgsana* is chiefly a coast dune scrub type. It forms scrub at Elberts Kraal several miles up the Gouritz River, and extends a considerable distance up all the river banks.

## III. THE VEGETATION OF THE LANGEBERGEN.

This includes not only the vegetation of the main mountain range but that of its outlier the Aasvogelberg and adjoining ridges near Albertinia.

## 1. The Succession of Bare Rock Surfaces and Cliffs.

A. *Lithophyte Succession.*

There are no cliffs on the Riversdale sea coast. Though often present in the Langebergen, they are not usually very high or sheer, being broken by ledges and small terraces. The succession here is apparently much the same as in the Drakensbergen where it was studied by Professor Bews. (An Account of the Chief Types of Vegetation in South Africa, 1916.)

(1) *Associations of Cyanophyceae.*—These represent the first stage in the succession. They show themselves in the rocks often as black areas varying from an inch to several yards in diameter, but they do not reach the size seen further east where the climate is warmer and moister. They are more numerous on the southern aspect of the range, where they derive moisture from the south-east cloud, and are developed to a much less degree on the drier northern aspect. In very dry weather this black layer dries up and desquamates, leaving the rock once more bare. They are also to be seen on moist cliffs and near waterfalls in sheltered warmer places. No detailed examination has been made of such deposits, although material thereof was sent to Europe.

(2) *Lichen Associations.*—The dry hot summers are more favourable to the extensive development of these associations than of the preceding ones. One of the commonest lichens is *Parmelia proboscidea*, which occurs as flat greyish-white cakes, and is responsible for much of the colouring of the rocks. It reaches the summits and often grows intermixed with *Cladonia furcata*. A species of *Umbilicaria* is found frequently, appearing as flat discs centrally attached below, soft and flexible after rain, but dry and brittle in summer. *Parmelia levigata* is abundant on dry rocks, reaches to the summits of the mountains or nearly so, and is also often associated with *Cladonia*. It appears as a thin greyish-white layer on the rocks. *Usnea florida* variety *strigosa* grows plentifully in the form of upright pale bushy tufts, usually on open rocks but sometimes in crevices, and is found up to 3,500 feet or higher. *Cladonia squamosa* is another common species. *Siphonia tabularis* occurs on vertical or sloping rocks which are sometimes dry, but after rains are covered with a thin layer of running water, in which the lichen in the open sunshine appears as a continuous thin brilliant white covering closely resembling coral.

Another remarkable species is *Lecanora cinnabariza*, which is seen as smaller or larger vermilion stains on the rocks and is very common. It is often found associated with black and grey splashes due to other lichens, not only in dry but in damper localities. In the Langeberg it is sometimes seen invading the darker patches produced by *Cyanophyceae*. All these patches are very nearly level with the rock surface. A species of *Pertusaria* produces similarly greyish discolorations on cliffs and rocks.

(3) *Associations of Mosses and Hepatics*.—These usually constitute the third stage in the effort to produce vegetation in such localities, and assert themselves as pioneers until the Chomophyte stage appears. The commonest moss is perhaps *Syrrhopodon pomiformis*, found as cushion-like mosses on the rocks where the slightest depression affords a hold, in rock crevices and on trees. It appears often in dry but is also frequent in damp localities. *Stereodon cupressiformis* forms little mats or cushions on rocks, and on small ledges. *Polytrichum piliferum* in damp places often prepares the way for the orchid *Satyrion saricolum*, and *Catagonium mucronatum* is also here a common moss. Near waterfalls, and in localities more or less damp, the hepatics *Pallavicinia Lyelli*, *Lepidozia capillaris*, *Symphogyna Lehmanniana*, and *Cephalozia Pillansii* are often met with, singly or more usually in combination, and are frequently associated with the hygrophilous mosses *Campylopus introflexus* and *Fissidens glaucescens*. *Hymenophyllum fumarioides* and *Elaphoglossum petiolatum* appear here later. These ferns, however, are sometimes found with *Usnea florida* and *Syrrhopodon pomiformis* in places which are fairly dry, and are then dependent for moisture on the south-east cloud and mists. On moist rocks a combination of *Rhacocarpus ecklonianus* and *Campylopus introflexus* often occurs. *Sphagnum capense* is abundant on every permanently dripping rock, by waterfalls and streams frequently in the open sun and also *S. Rehmanni*. *Jamesoniella colorata* is another hepatic which can exist also in drier localities associated with *Hymenophyllum fumarioides*. *Lycopodium carolinianum* is common on rocks, often where water is continually running over it.

As concrete examples of the inter-relationship of these three stages, and also of the next, the following observations were made in the Langebergen:—

- (a) *Usnea florida* with *Syrrhopodon pomiformis* followed by *Lycopodium guidioides* on ledges and in clefts in dry localities: also with *Ficinia tristachya*.
- (b) *Cladonia* sp. with *Stereodon cupressiformis* and seedlings of *Crassula rubricaulis* growing in the latter.
- (c) *Cladonia* sp. with *Syrrhopodon pomiformis* and *Crassula punctulata* growing through the moss in dry places.
- (d) *Syrrhopodon pomiformis* with seedlings of *Mesembrianthemum deltoides* in dry clefts and narrow ledges.
- (e) In shallow rock cups *Cladonia squamosa* followed by *Campylopus introflexus* and *Rhacocarpus ecklonianus* in places of moderate dampness.
- (f) *Parmelia proboscidea* and *Cladonia furcata* intermixed with *Campylopus introflexus* growing through the substance of the lichens.

- (g) *Siphonia tabularis* on a vertical rock with water running over it, and a wet deposit containing *Cyanophyceae* intimately surrounding. The mosses *Campylopus introflexus* and *Rhacocarpus ccklonianus* grow in this deposit, and are mixed with the *Siphonia* on the margins. On the same rock there were great masses of *Sphagnum capense*.

Of the mosses mentioned *Rhacocarpus* and *Syrrhopodon* are altogether western genera, and *Sphagnum* mostly so. *Fissidens* and *Stercodon* are widely distributed or in some form almost cosmopolitan. *Jamesoniella colorata* is absent in the east and abundant in the west.

The phanerogamic species *Crassula rubricaulis*, *C. punctulata* and *Mesembrianthemum deltoides* are examples of the next stage in the succession, and are all succulent xerophytic types common in the neighbouring areas.

### B. Chomophyte Succession.

A list of all plants found in clefts and ledges on the cliffs of the Langebergen would include most of its vegetation. Many of the species recorded herewith are obligatory chomophytes, although some are invaders. They are arranged according to the classification of Professor Bews.

1. *Exposed Chomophytes*.—These are fully exposed to sun and weather in rock clefts or on ledges with little soil, and are mostly xerophytes. Examples are *Oldenburgia paradoxa*, *Erica gigantea*, *Rochea jasminea*, *Crassula punctulata* (usually), *Crassula rubricaulis* (frequently), *C. perforata*, *C. orbicularis*, *Kalanchoe rotundifolia* (occasionally), *Mesembrianthemum deltoides*, *Bulbine rostrata*, *Othonna amplexicaulis* (occasionally), *Aloe arborescens* (frequently), some *Restionaceae*, *Gleichenia polypodioides* (occasionally), *Blechnum tabulare*, *Pellaea hastata*, *Asplenium adiantum-nigrum*, *Cheilanthes hirta* variety *contracta* (sometimes), *Lycopodium gnidioides*, *Ficinia tristachya* (sometimes), *Syrrhopodon powiformis*, *Stereodon cupressiformis*.

2. *Sheltered Chomophytes*.—This is a large class growing more luxuriantly in deeper soil and including many bulbous plants. A few show more tendency to mesophytism. They are more protected from adverse climatic conditions. This section is represented by *Erica tenuicaulis*, *E. iranthera*, *Muraltia leptorhiza* (occasionally), *Crassula campestris* variety *laxa*, *C. centauroides*, *C. orbicularis* (sometimes), *Haworthia lactevirens*, *Scilla* sp. Muir 3004, *Ornithogalum schlechterianum*, *O. caudatum*, *Chlorophytum elatum*, *Bulbine alooides*, *Tritonia* sp. Muir 3075, *Gladiolus montanus* (sometimes), *G. apiculatus* (sometimes), *Disa sagittalis*, *D. ferruginea*, *D. capricornis*, *Aloe arborescens* (sometimes), *Lobelia pubescens*, *Cineraria sarifraga*, *Lachnaca passerinoides* (frequently), *Polypodium ensiforme*, *Elaphoglossum conforme*, *Aristea fruticosa*, *Nerine humilis*, *Restionaceae* (many species), many *Bryophyta* such as *Polytrichum piliferum*.

It is, however, not always possible to refer some of these species to their class, as their habitat in the Langebergen varies often considerably.

3. *Shade Chomophytes*.—These are chiefly ferns and mosses and include few flowering plants. Examples are *Peperomia retusa*, *Adiantopsis capensis*, *Holothrix lindleyana*, *Brownia secunda*.

4. *Hydrophilous Chomophytes*. The rocks here are constantly wet. Plants found in such places are *Hymenophyllum fumarioides*, *H. tunbridgense*, *Elaphoglossum petiolatum* (frequently), *Blechnum attenuatum*, *B. punctulatum* (occasionally), *Gleichenia polypodioides* (occasionally), *Drosera* spp. (sometimes), *Ficinia* n. sp. Muir 3427, *Satyrium saricolum*, and many mosses and hepatics. *Laurentia pygmaea* is found in rocks where there is a considerable amount of moisture.

## 2. The Sclerophyllous Vegetation of the Langebergen.

### (a) Heath.

This type of vegetation is not climax, but is an earlier stage in the succession to Macchia. The account of both of these given herewith is based on observations made on the southern side of the mountains. The former corresponds largely to the Hügelerde of Dr. R. Marloth, and ericoid leaved species assume here dominance. The "heathland" is a treeless region, largely situated on the rounded foothills and lower mountain slopes. It receives less rain than most of the true macchia, and at the height of summer fairly dry conditions frequently prevail. It is more exposed to mountain fires and to interference by man and cattle. The vegetation is seldom here more than three or four feet high and many plants are common to it and to the macchia. Species of *Erica* are dominant, among which *Erica versicolor* is tallest reaching sometimes a height of six feet. Several of them grow socially, and this is one of the main features of this region; e.g. *Erica cordata*, *E. deliciosa*, *E. quadrangularis*, *E. copiosa*, *E. peltata* and *E. melanthera*. They form larger or smaller patches, but *E. melanthera* and *E. deliciosa* are visible to the naked eye at a distance of several miles as a distinct pink tinge on the mountains. *Erica hispidula* grows in areas of medium size, and this and most of those mentioned have inconspicuous flowers when viewed singly and only produce colour in mass. *Erica racemosa* is a semi-social form. *Elytropappus rhinocerotis* also occurs here but not extensively, and chiefly along roads and in the lower part of the region nearer the Renosterveld. Other species of *Erica* are *E. regerminans*, *E. microcodon*, *E. adnata*, *E. imbricata*, *E. articularis* and *E. paliiflora*. Many of the species belonging to the minor genera of *Ericaceae* are abundant, such as *Blacra pusilla*, *B. coccinea*, *B. Murrillii*, *Phyllipia pallida*, *Thoracosperma puberulum*, *Simocheilus depressus*, *Anomalanthus scoparius* and *Anisericia gracilis*. *Thesium ericaefolium* often grows socially covering small areas. *Berzelia intermedia* or *Metalasia muricata*, both types of ericoid leaved shrubs are dominant in places, and other similar leaved forms are *Selago spuria*, *Anthospermum aethiopicum*, *Helichrysum ericaefolium*, *Stoebe cinerea*, *S. tortilis*, *S. aethiopica*, *Passerina filiformis*, *Aspalathus* spp., *Murraltia ericaefolia*, *M. ciliata* and *Spatalla parilis*. Plants with leaves approaching the myrtiform type are *Penaea mucronata*, *Struthiola hirsuta*, *Euclea polyandra* and some *Phytolaeas*. *Proteaceae* are not so frequent here as in the true macchia but *Leucadendron adscendens*, *Mimetes lyriogera*, *Protea mellifera* and

*P. neriifolia* are representative and none have ericoid leaves. *Rhus rosmarinifolia*, *Hydrocotyle virgata*, *Thesium* spp., and several species of *Claytia* with narrow leaves, are noticeable here. There are no grasslands, the grasses being scattered about thinly among the shrubs and herbaceous species.

A list of plants found in this type of vegetation is given herewith:—

Filices: *Pellaea hastata*, *Adiantopsis capensis*, *Cheilanthes hirta* and *Schizaea pectinata*.

Cyperaceae: *Macrochactium Dreyei*, *Tetraria Rottboellii*, *T. rottboellioides*, *T. cuspidata*, *T. compar*, *Scirpus antarcticus* and *Ficinia albicans*.

Gramineae: These are numerous, especially on burnt off places, viz., *Cynodon Dactylon*, *Trachypogon plumosus*, *Digitaria eriantha*, *Achneria capensis*, *Stenotaphrum glabrum* (in damp places), *Pentaschistis currifolia*, *P. Thunbergii*, *Andropogon hirtus*, *Danthonia lanata*, *Ehrharta longifolia*, *Melica racemosa*, *Themeda Forskalii* and *Brizopyrum capense*.

Restionaceae: *Staberoha cernua*, *Restio triticeus*, *R. scaberulus*, *R. hystrix*, *R. filiformis*, *R. foliosus*, *Dorea bracteata* and *Thamnochortus argenteus*.

Liliaceae: *Bulbine pugioniformis*.

Amaryllidaceae: *Cyrtanthus lutescens*.

Iridaceae: *Bobartia spathacea*, *B. anceps*, *B. Burchellii*, *Babiana disticha*, *Tritonia crocata*, *Gladiolus blandus*, *Antholyza nerrosa*, *A. Lucidor* and many others. The *Bobartias* are resistant to and increased by veld burning.

Orchidaceae: *Pachites Bodkini*, *Disa tripetaloides*, *Satyrium* spp. and many others. Well represented here.

Haemodoraceae: *Wachendorfia paniculata*, *Lanaria plumosa*.

Proteaceae: *Mimetus lyrigera*, *Serruria Knightii*, *S. Burmanni*. The *Serrurias* have bipinnately divided leaves with filiform segments.

Rosaceae: *Cliffortia ferruginea*, *C. filifolia*, *C. octandra*.

Crassulaceae: *Crassula ciliata*, *C. ericoides*.

Santalaceae: *Thesium*, many spp.

Grubbiaceae: *Grubbia stricta*.

Aizoaceae: *Mesembrianthemum blandum*, *M. pentagonum*, *M. falcatum*, and a few others. Poorly represented.

The genus *Erepsia* (formerly section *Bracteata*) is rather typical.

Leguminosae: *Priestleya hirsuta*, *Amphithalea intermedia*, *Lebeckia pauciflora*, *Aspalathus parviflora*, *A. nigra* and several other species of this genus with reduced leaves. *Indigofera heterophylla*, *Rhynchosia glandulosa*.

Rutaceae: *Colconema pulchrum*, *Agathosma chortophila*, *A. struthioloides*, and other spp. all with ericoid leaves.

Euphorbiaceae: *Euphorbia ericoides*, *Claytia* spp.

Polygalaceae: *Polygala ericaefolia*, *P. virgata*, *Muraltia macroceras* and *M. alopecuroides*.

Rhamnaceae: *Phylica axillaris*, *P. velutina*, *P. gracilis* and others.

Guttiferae: *Hypericum aethiopicum*, *H. Lalandii*.

- Thymelaeaceae: *Struthiola virgata*, *G. oppositifolia*, *G. sericea*  
*G. scabrida*, *Passerina* spp.  
Ericaceae: *E. nematophylla*, *E. leucopelta*, *E. curviflora*  
variety *b.*, *E. diaphana*, *E. formosa*, *E. ardens*, and *E.*  
*stenbergiana*.  
Geraniaceae: *Pelargonium* spp.  
Oxalidaceae: *Oxalis pulchella* and others.  
Gentianaceae: *Sebaca exacoides*.  
Asclepiadaceae: *Asclepias rotundifolia*.  
Scrophulariaceae: *Harrega Bolusii*.  
Borraginaceae: *Lobostemon* (three species).  
Verbenaceae: *Stilbe phylacoides*, *S. vestita* (both ericoid).  
Selaginaceae: *Selago ramosissima* (an ericoid leaved species).  
and others of this genus.  
Campanulaceae: *Lobelia pinifolia*, *L. tomentosa*, *L. hirsuta*,  
*Lightfootia fasciculata*, *Wahlenbergia robusta*, *Roella*  
*ciliata*, and *Cyphia digitata*.  
Compositae: *Aster barbatus*, *Ursinia* (many species), *Leon-*  
*tonyr glomeratus*, *L. squarrosus*, *Stoebe* spp., *Senecio*  
spp., *Euryops abrotanifolius*, *Dimorphotheca Tragus*, *D.*  
*nudicaulis*, *Helichrysum teretifolium*, *H. cochleariforme*,  
*Osteospermum triquetrum*, *Arctotis acaulis*, *A. pinnati-*  
*folia*, *Gazania pinnata*, *G. longiscapa*, *Gerbera pilosello-*  
*ides*, *G. ferruginea*, *Printzia Bergii* and *Berkheya*  
*carthamoides*.

The soil is sandy, and varies from three to twelve feet in depth. It is derived from decomposition of the Table Mountain Series.

A noteworthy feature of the foregoing list is that very many of the species, representing families widely separated, possess leaves greatly reduced in size and heath like in form. Such specific names as "ericoides," "ericifolia" and "pinifolia" are numerous and significant of the prevailing type of vegetation. An increased hardness of the leaves is also characteristic of many of the plants recorded.

"Flashes" in the Heath Area.—These occur where springs emerge from the Table Mountain Series, are usually small in size, and variable in the amount of water they contain. Where the spring issues from the sandstone the vegetation is usually more helophytic than that found nearer the lower border of the area. The types in such places are migratory. In flashes of medium wetness *Laurembergia repens* is dominant. In others *Juncus lomatoxyllus* is dominant in the wetter portions, and the *Laurembergia* in the parts which are somewhat drier. The plants present, taken in order of frequency from the wetter "eye" of the flush towards the merely damp and drier end or "tail," are *Carpha bracteosa*, *Cyperus tenuis*, *Fuirena hirta*, *Picinia striata*, *Utricularia capensis*, *U. Ecklonii*, *Hydrocotyle asiatica*, *Drosera cuneifolia*, and *Pulicaria capensis*. At the "tail" much of the water has disappeared and no longer lies free on the surface. Many orchids occur here especially *Orthopenthea bivalvata*; also the plants *Lobelia corymbosa*, *Monopsis scabra*, *Crassula langenbergensis*, *Pygmaeus umbrosus*, *Stenotaphrum glabrum*, *Lycopodium carolinianum* (also in water semi-submerged), and *L. cernuum*.



*Mountain Rills in the Heath Area.*—Sometimes the “flushes” instead of dying away, continue as tiny streams down the mountain side, but in either case hygrophilous *Ericaceae* often occur, e.g. *Erica cubica*, *E. tetrathecoides*, *E. curviflora*, and to a less extent *E. quadrangularis* and *E. racemosa*. *Erica caffra* is also hygrophilous but is found oftener by streams in ravines and near mountain waterfalls. On the banks or in the beds of such rills grow also *Todea barbara*, *Cliffortia strobilifera*, *Psoralea aphylla*, *P. oligophylla*, *Myrica conifera*, *Elegia verticillaris*, *Dovea mucronata*, *Gleichenia polypodioides* and several *Orchidaceae*.

Most of these shrubs, as well as *Cyclopia tenuifolia*, occur also on the margins of the deep channels or “moss hags” previously mentioned. These trenches are often eight feet or more deep, and their walls are of black wet soil or mud. The current is usually slow, often almost still, but strong after rains. *Disa falcata* covers the walls with a dense, continuous carpet like moss, thousands of plants being crowded into a small area, sometimes almost in water, and must be submerged temporarily although rarely by floods. Usually, however, they are a few feet distant from the stream. Other orchids common here are *Disa uncinata*, *Satyrium stenopetalum*, and again *Orthopenthea bivalvata*. Other families are represented by *Utricularia capensis* and *U. Ecklonii*, which are here more often terrestrial than aquatic, *Xyris capensis*, *Drosera capensis*, *Indigofera filifolia*, and *Lycopodium carolinianum*, which are all found in the mud at the bottom or sides. The type of stream bank vegetation described above is also migratory, and characteristic of most similar situations in Riversdale, Swellendam, and Mossel Bay Divisions.

#### (b) *Macchia*.

Heath passes insensibly into true *Macchia*. This sclerophyllous type of vegetation, known in South Africa as “Fynbos,” is closely related ecologically to the *Macchia* of the Mediterranean region, and to the Chaparral of California (Cooper. The Broad Sclerophyll Vegetation of California, 1922), although the constituent species of course differ. It is more extensive than the heathland, and consists of a multitude of woody, evergreen shrubs, but not forest trees, possessing frequently leaves much reduced in size, often ericoid or occasionally pinoid, hard and with a thick cuticle. The *Proteaceae* generally speaking are an exception as regards size of leaves, but the following species here of this family have pinoid, or filiform or narrow linear leaves:—*Aulac pinifolia*, *A. pallasia*, *Leucadendron abietinum*, *L. uniflorum*, *L. ericifolium*, *L. platyspermum* (lower leaves), *Protea lorea*, *Spatalla parilis*, *S. Bolusii*, *S. barbigera*, and *Nivenia diversifolia*. Most species of *Nivenia* and *Serruria* have divided leaves with terete or cylindrical segments. Most shrubs in the *macchia* have well-developed root systems.

True *macchia*, when undisturbed by fires, varies from six to twenty feet in height, but typical tall growth is becoming more and more difficult to find, and nearly everywhere only a low insignificant vegetation, often three to five feet high, represents the luxuriant form which Thunberg and Burchell saw. Its general colour varies with distance and light. Viewed from afar it is dark green; nearer, where the slopes are covered with species of *Berzelia*, or in direct sunlight,

it is greyish green, and over immense areas where species of *Leucadendron* are dominant, lighter still. On slopes where it had not been burnt within the memory of man, the appearance of the macchia in 1924 was as follows. It has since been destroyed by fire. Entering a pathway the shrubs met overhead, and were so dense that it was impossible to advance without pushing the branches aside. Five species were most frequent and striking, namely *Protea neriifolia*, which was the first met with on the ascent, then *Protea latifolia*, *P. longiflora*, and *Cliffortia ilicifolia*, all with very large leaves except the last named, and lastly *Leucadendron strictum*. This was dominant and coloured the mountain side with yellow, visible at the writer's house eight miles distant. *Leucadendron grandiflorum* and *L. platyspermum* grew on the slopes above. Other shrubs in such places are *Leucospermum Mundii*, *L. attenuatum*, *Mimetes splendida*, *M. lyri-gera*, *M. hirta*, *Podalyria* spp., and *Lanrophyllus capensis*, most of them with broad leaves and the minor sclerophyllous character of hairiness. *Berzelia squarrosa* and *Hiddingttonia cupressoides* are very common. *Ericaceae* and ericoid types are frequent in the Macchia, especially in more open places on the stony and shingly slopes, e.g. *Erica adunca*, *E. grata*, *E. vestita*, and *E. melanthera*, some of them forming large and nearly pure patches. *Pelargonium cordatum* and *P. ternatum* are also frequent, the latter with hard, brittle scabrous leaves. *Helichrysum vestitum*, *Helipterum phlomoides*, and *H. erimium* have leaves resembling closely pieces of flannel. The prevailing families on every side are seen to be *Restionaceae*, *Proteaceae*, *Ericaceae*, *Geraniaceae*, *Compositae*, and *Leguminosae*, represented often by their most sclerophyllous species. Families sparsely represented or absent are *Asclepiadaceae*, *Salvadoraceae*, *Malvaceae*, *Cucurbitaceae*, *Sapotaceae*, *Melanthaceae*, *Euphorbiaceae* (chiefly in mountain woods), and *Acanthaceae*. These are more numerous in the Renosterveld and in the Strandveld. Where the mountain slopes dip towards the ravines, *Cannomois capensis* grows up to twelve feet in height, and *Psoralea pinnata*, *Carpha glomerata*, and *Rubus pinnatus* in places nearer the stream.

There is a more or less tangled undergrowth, subordinate usually, consisting of *Lobelia hirsuta*, *Osteospermum* sp. Muir 2985, *Helichrysum paniculatum*, *H. sesamoides*, *Loddigesia ovalidifolia*, *Indigofera* spp., *Cassytha ciliolata*, *Callunia hispida*, *Cliffortia dentata*, *Thesium* spp., *Hydrocotyle virgata*, and in more open spaces *Pteridium aquilinum*. *Restionaceae* abound both in open spaces and among shrubs, the commonest here being *Restia hystrix*, *R. filiformis*, *R. triticeus*, *R. fruticosus*, *Thamnochortus argenteus*, and *Leptocarpus paniculatus*. Some *Cyperaceae* in this region have a xerophytic aspect, and some resemble *Restionaceae* at a distance, e.g. *Tetraria compar*, *T. Rottboelliioides*, *T. ustulata*, and others. *Pentameris Thunbergii*, growing on rocks and six feet high, and *Ehrharta ramosa*, four feet high, are uncommon and remarkable grasses with ligneous culms, suffrutescent and almost shrubby in habit. *Pentameris speciosa* is common.

A list of some of the numerous species found in Macchia is given :  
Filices: *Asplenium lunulatum*, *A. praemorsum*.

Cyperaceae: *Ficinia bracteata*, *F. acuminata*, *Tetraria thermalis*, *T. secans*, and *T. involucreata*.

Gramineae: These grow scattered about among the shrubs, viz.: *Tricholaena rosea*, *Achneria capensis*, *Pentaschistis*

*colorata*, *P. Thunbergii*, *Danthonia lanata*, *Agrostis bergiana*, *Cynodon Dactylon*, *Chloris petraea*, *Ehrharta* spp., *Aristida capensis*, *Themeda Forskalii*, *Lasiochloa ciliaris*, *Andropogon appendiculatus*.

**Restionaceae:** The most important are *Restio* (14 species), *Dorea* (3 species), *Elegia* (9 species), *Leptocarpus* (5 species), *Thamnochortus* (4 species at least), *Staberchia* (1 species), *Hypolaena* (2 species), *Hypodiscus* (5 species), *Cannomois* (2 species), *Willdenowia* (3 species at least), *Anthochortum* (1 species). Characteristic and well represented.

**Haemodoraceae:** *Dilatris corymbosa*, *D. viscosa*, *Lanaria plumosa* and *Cyanella lutea*.

**Liliaceae:** *Lachenalia unifolia*, *Kniphofia alooides*, *Bulbine* spp., *Asparagus plumosus* and other species, *Aloe arborescens*.

**Iridaceae:** *Romulea chloroleuca*, *Aristea Zeyheri*, *A. capitata*, *Geissorhiza secunda*, *G. creisa*, *Watsonia* spp. (spread by the destruction of the Macchia by fire very noticeably), *Tritonia pallida*, *T. Bakeri*, *Gladiolus grandis*, *G. recurvus*, *G. apiculatus*, *G. montanus*, *G. Bolusii* variety *Burchellii*, *Bobartia anceps*, *B. Burchellii*, *Klattia partita*, *Antholyza aethiopica*, *Babiana disticha*, and many others. *Gladiolus* is strongly represented and most of the *Iridaceae* mentioned withstand fire well and are seen very abundantly on burnt-off places. The same remarks apply specially to *Bobartia* as well.

**Amaryllidaceae:** *Hypoxis argentea*, *Buphane disticha*, *Cyrtanthus lutescens*.

**Orchidaceae:** Well represented, and many are able to withstand fire. *Aerolophia lamellata*, *A. lunata*, *Satyrium* (many species), *Holothrix* spp., *Habenaria arenaria*, *Pachites Bodkini*, *P. appressa*, *Orthopenthea* (3 species), *Monadenia* (4 species), *Herschelia graminifolia*, *Penthea patens*, *P. filicornis*, *Disa* (many species), and *Schizodium*, *Ceratandra*, *Ceratandropsis*, *Pterygodium*, *Corycium* and *Disperis* have all representatives.

**Proteaceae:** *Anax* (3 species), *Leucadendron salignum*, *L. plumosum*, *L. radiatum*, *L. strictum* and six others, *Protea* (13 or 14 species), *Leucospermum* (6 species), *Mimetes* (3 species), *Serruria* (1 or 2 species), *Spatalla* (3 species), and *Nivenia* (4 species).

**Santalaceae:** *Thesium euphorbioides* and many other species. **Grubiaceae:** *Grubbia stricta*, *G. rosmarinifolia*.

**Ranunculaceae:** *Anemone capensis*, *Kuorltonia resicatoria*.

**Cruciferae:** *Heliophila glauca*, *H. virgata*.

**Rosaceae:** *Cliffortia* is typical, represented by two broad-leaved species *C. grandifolia* and *C. ilicifolia* and other species with narrow leaves. *C. pulchella* has orbicular leaves like an *Adiantum*. *Rubus pinnatus*.

**Bruniaceae:** A small but characteristic family represented here by the genera *Pseudobaeckea*, *Brunia*, *Berzelia*, *Raspalia* and *Linconia*.

**Crassulaceae:** *Grammanthes gentianoides*, *Roechia jasminea*, and *Crassula* (many spp.). This family is more numerously represented on the northern slopes.

- Leguminosae: *Cyclopia subternata*, *C. brachypoda*, *Liparia comantha*, *Rafnia* spp., *Lotononis azurca*, *Psoralea tomentosa*, *Aspalathus* (many species), *Indigofera coriacea* (and other species with hard leaves), *Tephrosia capensis*, *Dolichos gibbosus*, *Rhynchosia* spp., *Podalyria* spp., *Amphithalea intermedia*, and *A. violacea*.
- Geraniaceae: *Pelargonium candicans*, *P. ternatum*, *P. angulosum*, *P. zonale* and many others.
- Oxalidaceae: *Oxalis heterophylla*, *O. lanata*, *O. variabilis* and others. They do not succumb to fires and occur on open burnt-off places.
- Linaceae: *Linum* spp.
- Rutaceae: *Adenandra fragrans*, *Acmadenia psilopetala*, *A. tetragona*, *Empleurum serratifolium*, *Diosma* spp., *Barosma serratifolia*, *Agathosma* spp.
- Rhamnaceae: *Phylica* spp.
- Penaceae: *Penaea* (4 species), *Endonema Thunbergii*.
- Anacardiaceae: *Rhus obovata*, *R. tomentosa*, *R. incana*, *R. mucronata* and *R. lucida*.
- Malvaceae: *Malvastrum capense*.
- Thymelaeaceae: *Lochna diosmoides*, *L. cricoides*, *Struthiola* spp., *Gnidia pulvinata*, *G. Galpini*, *Passerina* spp. Well represented.
- Umbelliferae: *Hermas ciliata*, *Alepidea eiliaris*.
- Ericaceae: *Erica* (at least 80 species in macchia and heath together). Minor genera represented are *Blaeria*, *Thoracospema*, *Anomalanthus*, *Simochilus*, *Syndesmanthus*, *Phillipia*, *Coilostigma*, *Platycahyx*, *Aniserica*, *Leptericia* and *Scyphogyne*.
- Myrsinaceae: *Myrsine africana*.
- Gentianaceae: *Sebaea Dregei* and several others, *Chironia jasminoides*.
- Selaginaceae: *Selago brevifolia*, *S. luxurians* and others with more or less ericoid leaves.
- Scrophulariaceae: *Nemesia* spp., *Halleria lucida*.
- Campanulaceae: *Lobelia pinifolia* and other species, *Theilera Guthriei*, *Lightfootia* spp., *Prismatocarpus* spp.
- Compositae: Largely represented, but like many of the preceding families, subordinate ecologically to other macchia shrubs:—*Ursinia brachypoda*, *U. trifida*, *U. scariosa*, *Hippia gracilis* (common in the undergrowth), *Helichrysium* spp., *Helipterum eximium*, *Metalasia muricata* (the commonest Composite in the mountains), *Stoebe* spp., *Phacnoma prolifera*, *Athrixia heterophylla*, *Osmites Bellidiastrum* (in the undergrowth often, or exposed), *Othonna* spp. (in more open places), *Senecio pinifolius* (and other species), *Arctotis* spp., *Venidium perfoliatum*, *Callumia* spp., *Berkheya lanceolata*, *B. cruciata*, *Stephanocoma carduoides*, *Kleinia crassulaefolia*.
- Geissolomaceae*, represented by one genus with a single species *Geissoloma marginatum*, is only known from the Riversdale Division, and the adjoining portion of Swellendam. It is a broad sclerophyllous type.

(e) *Upper Southern Slopes and Summit.*

Ascending to higher levels *Proteaceae* are observed to become more scarce. *Protea cynaroides* reaches a higher altitude than the others here, except *Protea longiflora*, which reaches the summit. *Leucadendron grandiflorum* and *L. minus* are still found, and a few *Ericaceae* such as *Erica inclusa*, *E. ardens*, *E. arachnoidea* and *E. macilentata*. Other shrubs here are *Othonna amplexicaulis*, *O. parvifolia*, *Grubbia striata*, *Ursinia trifida*, *Thesium galioides*, *Gymnosporia laurina*, *Anthospermum aethiopicum* and *Phaenocoma prolifera*. *Aristea fruticosa* appears next and *Tetraria thermalis* still persists, growing on ledges and in rocky places. *Achueria capensis* is the commonest grass, and in some localities *Poa annua*. *Eriinia tristachya* (often a chomophyte) and *Chrysithrix capensis* are abundant. The vegetation becomes more stunted with *Restionaceae* predominant, especially *Restio triticeus*, *R. gaudichaudianus*, *Cannomois* spp., and *Hypodiscus aristatus*. *Gladiolus crispulatus* and *Hermas ciliata* are common at this elevation. Near the summit of the Kampsche Berg Burchell found *Hypolaena anceps* and *Anthochortus Ecklonii*.

The mountain summits are sometimes flat with or without broad shallow depressions. The soil is in parts wet throughout the year, but in other parts, at least during summer, dry. Even in December and January, the driest time of the year, many rills cut shallow channels in the black sandy soil, and form tiny pools with rocky bottoms. Elsewhere there is exposed rock, and the ground is covered with rock fragments and detritus. The most noticeable features on the summit of the Witte Els Berg are the absence of trees, scarcity of shrubs, and the presence of a hard, dense mat-like vegetation. This is composed chiefly of *Cyperaceae*, and *Restionaceae* with a few *Ericaceae* and *Compositae*. The chief shrubs are *Leucadendron minus*, *L. radiatum*, *Raspalia Schlechteri*, *Berzelia Burchellii*, *Psoralea pinnata* (a hairy form), *P. aphylla*, *Stilbe phylacoides*, *Stilbe* n.sp. Muir 1251, and *Teedia lucida*. Many orchids are found here, which have a later flowering period than when growing at lower altitudes, viz.: *Disa uncinata*, *D. Vasselotii*, *D. obtusa*, *D. falcata*, *D. cylindrica*, *D. glandulosa*, *D. capricornis*, *Monadenia ophrydea*, *Orthopenthea Bodkini*, *Schizodium inflexum*, *Satyrium acuminatum*, *Corycium carnosum*, *Disperis paludosa* and *Ceratandra atrata*. Of these *Disa Vasselotii* and *D. falcata* grow besides the rills, the others in damp places, and all within a comparatively short radius. These orchids were collected on November 1st and December 1st. Much of the moisture here arises from condensation from the south-east clouds. In July, mid-winter, the soil is sometimes frozen and covered with snow for a day or two. Other herbs here are *Anemone capensis*, *Mairea erenata*, *Helichrysum marifolium*, *H.* sp. Muir 2623 (all hairy or woolly forms), *Harveya tubulosa*, *H. stenosiphon*, and *Gazania pinnata*. Large rounded hummocks of *Oldenburgia paradoxa* (with thick leathery leaves beneath) are a striking feature in rock clefts, and *Agapanthus umbellatus* is abundant. The following *Ericaceae* have been noted at 4,000 to 5,000 feet:—*Erica macrophylla*, *E. dysantha*, *E. condensata*, *E. pulvinata*, *E. dianthifolia*, *E. chlorosepala*, *E. mucronata*, *E. Petiveri* and *Leptericia tenuis*. *Thymelaeaceae* are represented by *Lachnaea macrantha* and *Passerina rigida*. The most common *Restionaceae* are *Dovea mucronata*, *Elegia juncea*, and *Restio compressus*. *Chrysithrix junceiformis* grows on

the summits. In damp places near waterfalls and in water are hygrophilous mosses such as *Sphagnum copense* and *S. Rehmanni*, and in drier places below the northern edge others of a xerophilous type. Lichens found at high elevations in the Riversdale Division are *Usnea florida* variety *strigosa*, *Parmelia laevigata*, and *Cladonia* spp. *Gleichenia polypodioides* is the commonest fern. *Mesembrianthemum deltoides* occurs frequently on rocks, a very succulent type.

The summits are frequently visited by veld fires, usually unintentionally and by extension from lower levels. Some of the summits carry, however, a more luxuriant vegetation than that described here in outline.

*Plants Common to Base and Summit.*—These are:—*Protea longiflora*, *Berzelia Burchellii*, *Psoralea pinnata*, *P. aphylla*, *Teedia lucida*, *Mairea crenata*, *Gazania pinnata*, *Erica Petiveri*, *Passerina rigida*, *Disa falcata*, *Monadenia ophrydea*, *Disa capricornis*, *Mesembrianthemum deltoides*, *Poa annua*, *Restio compressus* and a few others.

(d) *Northern Slopes and Base.*

The differences between the vegetation of the northern and southern sides of the Langebergen are due chiefly to climatic factors. They are more largely in the direction of density and luxuriance than of species. The rocks on the northern side are not so well covered, due to a less absolute rainfall there, and the absence of the additional moisture which the southern side receives in summer from the south-east cloud. Another cause is connected with the degree and duration of insolation. Descending from the summit towards the Klein Karoo *Aloe arborescens* occurs abundantly at 3,200 feet, and other succulents such as *Crassula rubricaulis*, *C. perforata*, *C. punctulata*, *Cotyledon rhombifolia* variety *maculata*, *Mesembrianthemum deltoides*, and *Pelargonium* spp., many growing as chomophytes, and showing as a community an affinity with the last-named region. *Protea cynaroides* is the first of its family seen on the descent; then *Protea grandiflora*, *Leucadendron strictum* and *L. adscendens*. *Erica gigantea*, a very rare and xerophytic type, *Cluytia* spp., *Aemadenia psilopetala*, *Cliffortia pulchella*, and many *Restionaceae* are seen here, e.g., *Restio triticeus*, *R. compressus*, *Thamnochortus dichotomus*, *Leptocarpus Muirii*, *L. vimineus*, *Hypodiscus striatus*, *H. aristatus*, *Elegia Muirii*, *E. Galpinii* and *E. vaginulata*. *Ficinia pusilla* and *Tetraria* spp. represent *Cyperaceae*. *Danthonia elephantina*, a giant grass, is locally frequent among *Proteaceae*.

At the northern base there lies a strip of vegetation which constitutes the last outpost of the Langeberger machias. It extends to the border of the Renosterbos zone and is from one to two miles in width. It is situated at from 1,000 to 1,500 feet above sea-level, is very rocky and much cut by ravines. Here *Leucadendron adscendens* is dominant, and other *Proteaceae* are numerous, viz., *Protea mellifera* fera, *P. neruifolia*, *P. macrophylla* (the only Riversdale region), *P. lorea* (only Riversdale locality), *Leucadendron erieifolium* (only Riversdale locality), *Leucospermum diffusum* (rare), *L. puberum*, *L. Mundii*, *Nyctenia diversifolia* (only locality), and *Serruria Burmanni*. Other shrubs here are *Thesium strictum*, *T. penicillatum*, and *T. euphorbioides*, all from eight to ten feet in height, *Phaenocoma prolifera*,

*Helipterum gnaphaloides*, *H. canescens*, *Lobostemon Muirii*, *Psoralea* spp., *Aspalathus hirta*, *Pelargonium scabrum*, *P. violarium*, *Diosma* spp., *Phylica axillaris*, *Lachnaea ericoides*, *L. ambigua*, *L. passerinoides*, *Gnidia Francisci*, *G. Galpini*, *Struthiola virgata*, *Erica Plukenetii*, *E. caffra* (near water), *E. grata*, *E. Muirii*, *E. rhodantha*, *Blaeria Muirii* and *Mesembrianthemum politum*, many of which are rare or little known and show the prevalence of ericoid leaved types. *Erica vestita* and *E. dichrus* are in the eastern portion abundant.

Succulent plants at the northern base of the Langebergen are more numerous than on the southern side, especially *Mesembrianthemum* and *Crassulaceae*. *Mesembrianthemum albidum*, *M. politum*, *M. (Erepsia) Muirii*, and *Crassula decussata*, the latter a lately discovered species, are worthy of note. On the southern aspect they are less abundantly represented and are found chiefly in the genera *Aloe*, *Othonna*, *Kleinia*, *Mesembrianthemum*, *Crassula*, *Rochea*, *Pelargonium*, and *Bulbine*.

Among minor xerophytic characters noted chiefly in the vegetation of the southern site, hairiness is one of the most noticeable. Examples showing this are *Gerbera piloselloides*, *Eriocephalus umbellulatus*, *Athanasia tomentosa*, *A. filiformis*, *Stoebe* spp., *Helipterum* spp., *Helichrysum* spp., *Phacncoma prolifera*, *Leontonyx* spp., *Padalyria* spp., *Aspalathus longifolia*, *A. hirta*, *A. canescens*, *Argyrolobium* spp., and in the genera *Gnidia*, *Mimetes*, *Protea*, *Leucadendron*, *Hermas*, *Lanaria*, and *Hydrocotyle*, to mention a few among many. Thorns and prickles are not often present but are found in some species of *Aspalathus* (*A. acanthes*), *Asparagus* spp., and *Rubus pinnatus*. The leaves of *Cliffortia grandifolia* and *C. ilicifolia* show a tendency in the same direction.

*Note on the Leaves of Proteaceae.*—In a summary of the main evolutionary tendencies shown by the dominant shrubs of the "fijnbosch" of the South-Western Mountain Range, Professor Bews has said: "The Proteaceae, however, . . . have retained the flat type of leaf, relying on the increased hardness only." (Plant Forms, p. 159). Examples have been quoted above which show that this is too general and that a number possesses ericoid or pinoid leaves. Another interesting point is that in *Nirenia spathulata* (which includes *N. Muirii*) the upper leaves are broadly spathulate and the lower bipinnately-divided into terete segments. *Nirenia diversifolia*, recently rediscovered here, has the upper leaves narrowly oblanceolate, and the lower bipinnately-divided. *Nirenia Dregei*, from a neighbouring Division, has the upper leaves sometimes linear and the others divided. The Riversdale species are slender more or less upright shrubs with the broader leaves towards the light and air, and the lower divided leaves often more or less concealed by neighbouring shrubs in the macchia.

Heterophylly is also shown by two Riversdale species of *Leucadendron*, viz., *L. platyspermum*, which has linear oblanceolate upper leaves and nearly acicular lower leaves: *L. ericifolium*, very rare and only known previously from Swellendam, shows a somewhat similar arrangement. It is possible to find a series of Proteaceous plants from the Division showing every stage between the broadest leaved forms and the ericoid or pinoid forms.

Heterophylly exists also in the Australian genus of Proteaceae, *Hakea*.

### 3. The Langeberg Forest and Mountain Streams.

Forest is found usually in ravines and rocky sites, mostly on the southern aspect, sometimes on the eastern and western slopes, but not on the northern sides of the mountain range. A stream runs in nearly every case through the ravine over a rocky bed, and the forest is often shut in on one or more sides by cliffs or high steep stony slopes. The woods here described lie at from 500 feet to 1,300 feet above sea-level. They are remnant forest which once clothed a much greater extent of the mountains, and has been reduced in size by mountain fires and exploitation. They are not relict, and if left alone regeneration would still occur.

Near the stream trees and shrubs of a more or less markedly hygrophilous type are found, viz.: *Platylophus trifolius*, *Ilex capensis*, *Rapanea melanophloea*, and *Sparmannia africana*, the last-named uncommon in Riversdale but occurring in sites moderately to very moist. *Celtis kraussiana* and *Kigellaria africana* are common. *Hemitelia capensis*, the tree fern, is plentiful in the shade near water. *Metrosideros angustifolia* is the dominant shrub, with *Brachylaena uerifolia*, and in places *Brabeium stellatifolium* of nearly equal importance. Other prominent shrubs and small trees grow in more open spaces, and are usually hygrophilous in such sites, but are not strictly part of the forest, viz., *Myrica conifera*, *Rhus obovata*, *Erica caffra*, *E. cubica*, *E. racemosa*, *Senecio rigidus*, *S. lyratus*, *Priestleya Thunbergii*, *Psoralea pinnata*, *Crotalaria purpurea*, *Cyclopia tenuifolia*, *Hypocalyptus obovatus*, *Virgilia capensis*, and *Polygala virgata*.

Several tall *Restionaceae* grow in shingly places between the above-mentioned shrubs and the water, namely: *Restio callistachyus*, *R. foliosus*, *R. hystrix*, *R. gaudichaudianus* var. *b.*, *Elegia juncea*, *E. verticillaris*, and *Leptocarpus pauciculatus*, some of which may have been brought down from higher levels. *Cyperaceae* are represented by *Carpha glomerata*, *Ficinia stolonifera*, and *F. brevifolia*. Common ferns here are *Todea barbara*, *Blechnum capense*, and *B. punctulatum*.

On the floor of the ravine on the heaped-up islands of shingle, away from the water but occasionally reached by floods, *Pelargonium Rodala*, *Aspalathus longifolia*, *Oftia africana*, *Senecio anabilis*, and *Royena glabra* grow luxuriantly.

The principal trees and large shrubs in the woods are, taken together, as follows:—

*Canonia capensis*, *Curtisia faginea*, *Olea laurifolia*, *Hartogia capensis*, *Royena lucida*, *Gymnosporia acuminata*, *G. burifolia*, *Pterocelastrus variabilis*, *Scolopia Mundii*, *Apodytes dimidiata*, *Olinia cymosa*, *Podocarpus latifolia*, *Burchellia capensis*, and in some woods *Gardenia Rothmannia*. Of these *Canonia capensis* probably requires the highest degree of holard, and *Olinia cymosa* a medium amount.



In the layer of scandent species (lianes) are *Senecio deltoides*, *S. quinquelobus*, *Asparagus plumosus*, *Rhoicissus capensis*, *R. pauciflora*, and *Secamone Alpini*. *Scatia indica* takes on here a thorny liane form which makes progress through the wood difficult.

On the forest floor in the shade *Plectranthus fruticosus* grows up to six feet in height abundantly and is strongly moisture demanding, doing better on moist sites than on medium or dry ones with the same light intensity. *Galopina circatoides* is not uncommon, but *Adenochne Mercurialis* is rarer. *Hacmanthus albiflos*, *Holothric lindleyana*, *Habenaria arcuaria*, *Hypoestes aristata*, and *Stachys aethiopica* are all found here more or less in the shade usually near the forest margin.

*Schoenorrhaphium lauccum* is common in places, and both this and *Stipa dregeana* can endure a considerable amount of shade.

Epiphytic on forest trees are *Usnea barbata*, *Syrrhopodon pomiformis*, *Polypodium ensiforme*, *P. lanceolatum*, *Vittaria lineata*, *Asplenium theciferum*, *Peperomia reflexa*, and *P. retusa*.

Other ferns in the wood not already mentioned are *Dryopteris bergiana*, *Polystichum aculeatum*, *P. adiantiforme*, *Asplenium bipinnatum*, *Hypolepis sparsisora*, *H. bergiana*, *Pteris dentata*, *Histiopteris incisa*, and in glades *Pteridium aquilinum*.

Leaving the wood and proceeding up the mountain slopes above it, *Indigofera langebergensis* is found in masses, and *Crassula multiflora* and *Mesembrianthemum pentagonum* are locally abundant. Next appear *Metalsia muricata* and *Aspalathus hirta* (with large yellow furze-like flowers); and above these are *Leucadendron strictum* and the macchia of the Langebergen, the succession being thus indicated.

The composition of Riversdale mountain forest corresponds closely with that given by Dr. Marloth (Das Kapland, Jena, 1908) and by Dr. J. F. V. Phillips (Plant Succession and Ecology in the Knysna Region, Carnegie Yearbook, 1925) for Sub-tropical High Forest in the Knysna Division. Riversdale forest has, however, fewer component species.

The heath type of vegetation forms a stage in the plant succession to macchia. In this relation a quotation may be given from Dr. J. F. V. Phillips (l.c.) which applies nearly equally to Riversdale. "Fijnbosch is not climax over the greater portion of the plateaux but is transitional to forest: it exists as a subclimax due to the ever-recurring disturbance by man, chiefly through the agency of fire. Where protected, the succession moves on to subtropical forest. Fijnbosch is climax in the mountain spurs and summits, but in great areas of the plateaux and the foothills it holds ground that once bore forest. Relict stumps buried in the soil and relict communities in secluded positions, together with successional features, testify to this."

### Aasvogelberg and Ridges.

These are an isolated mass of Table Mountain Beds separated from the Langebergen by an area twelve miles wide, the latter consisting of a portion of the Renosterveld. It is the locality for

some rare species, and those common to it and to the Langebergen, but not found up to the present in the intervening area are marked with an asterisk:—

Proteaceae: \* *Protea neriifolia*, \* *P. mellifera*, \* *P. cynaroides*, \* *P. grandiflora*, \* *Leucospermum puberum*, \* *Leucadendron adscendens*, \* *L. eucalyptifolium*, \* *Leucospermum attenuatum*.

Ericaceae: *Erica versicolor*, \* *E. Plunketii*, \* *E. speciosa*, *E. peltata*.

Restionaceae: *Leptocarpus vimineus*.

Leguminosae: *Aspalathus asparagoides* (only Riversdale locality), *A. incurvifolia* (only Riversdale locality known at present), *Liparia Burchellii* (only locality).

Some rare plants belonging to various families are *Antholyza Muirii*, *Mesembrianthemum delicosum*, *Haemanthus magnificus*, *Muraltia anthospermifolia*, *Struthiola confusa*, *S. gareiana*, *Hydrocotyle virgata* variety *lanuginosa*, *Harveya hirtiflora* parasitic on *Cineraria alchemilloides*, *Berkheya Ecklonii* and *Holothrix pilosa* (only locality).

Filices: *Cheilanthes hirta*, \* *Polypodium ensiforme*, \* *Elaphoglossum petiolatum*, *Gleichenia polypodioides*, *Polystichum adiantiforme*.

Cyperaceae: \* *Tetraria compressa* (in rocky places), *Ficinia bracteata* grows up to the summit.

Liliaceae: *Bulbine alooides*, *Androeymbrium leucanthum*, *Lachenalia tricolor*, *Aloe arborescens*.

Orchidaceae: \* *Satyrium coriifolium*, \* *S. membranaceum*, \* *S. maculatum*, \* *Disa ferruginea*, \* *D. sagittalis*, *Herschelia renusta*, *Holothrix lindleyana*.

Amaryllidaceae: \* *Haemanthus albiflos*.

Iridaceae: \* *Geissorhiza setacea*, *G. ornithogalooides*, *G. humilis*.

The chief plants remaining are: *Cliffortia ruscifolia*, *C. falcata*, *Aspalathus alopecurus*, \* *A. hirta*, \* *Amphithalea violacea*, *Psoralea pinnata*, \* *P. restioides*, *Myrsine africana*, *Clausena inaequalis* (in kloofs), *Barosma scoparia*, *Acmadenia obtusata* variety *macropetala*, *Diosma vulgaris*, \* *Thesium virgatum*, *T. spicatum*, *Adenogramma diffusa*, \* *Mesembrianthemum deltoides*, \* *Crassula rubricaulis*, *C. punctulata*, *C. lycopodioides*, *C. clarifolia*, *C. campestris* var., *Pittosporum viridiflorum*, *Clytia polifolia*, \* *C. alaternoides*, *Hermannia salicifolia*, *H. flamma*, *H. angularis*, *H. hyssopifolia*, *Struthiola cricoides*, *S. virgata*, *S. argentea*, \* *Gnidia subulata*, \* *Peucedanum Galbanum*, *Myosotis sylvatica*, *Salvia aethiopica*, *Solanum geniculatum*, *Selago glomerata*, *S. spuria*, *S. ramosissima*, *Walafrida cinerea*, *Teedia lucida*, *Sutera aethiopica*, *S. integrifolia*, *S. revoluta*, *S. pedunculata*, *Plectronia ventosa*, *Anthospermum aethiopicum*, *A. ciliare*, *Scabiosa columbaria*, *Kedrostis Schlechteri*, *Lobelia pubescens*, *Lightfootia denticulata*, \* *Aster hirtus*, *A. filifolius*, *Metalasia pulcherrima*, *M. fasciculata*, \* *Ursinia dentata*, *Cotula turbinata*, *Helichrysum cymosum*, *H. crispum*, \* *H. sesamoides*, \* *Helipterum canescens*, *H. gnaphaloides*, *Gnaphalium undulatum*, *Stoebe sphaerocephala*, *Cineraria geifolia*, *Senecio ilicifolius* and *Osteospermum corymbosum*.

## IV. VEGETATION OF THE KLEIN KAROO.

The portion of the Klein Karoo here considered lies entirely on the Bokkeveld Shales which are exposed over a wide area. The type of vegetation that has been evolved differs greatly from those found south of the Langebergen, by tending very much less towards mesophytism, and by being more universally succulent and xerophytic. This character of succulence is present in many different families. Geophytes, or species with underground storage organs, are characteristic and numerous. Annuals, although few in number, are not absent and come up after rain, so that this area must be regarded rather as steppe and not as desert.

## 1. On the plains.

Here shrubs of a low dwarf type constitute the bulk of the vegetation, with occasional taller species. Between and separating them there is everywhere bare, hard-baked soil. Looking south towards the Langebergen, the vegetation appears in the distance sharply demarcated from the mountain macchia by a distinct grey line, which is the southern border of a narrow strip running parallel to the mountain range in which *Elytropappus rhinocerotis* is dominant. This strip is from one to two miles broad, and lighter in colour than the macchia. Closer inspection shows it to be invading the latter to a greater extent than on the southern aspect of the range. No *Proteaceae* occur in this zone except *Leucadendron adscendens*, but *Euclea undulata* eight or nine feet high is the commonest shrub, and *Rhus lancea* next in order of frequency. Other shrubby species are *Rhus coccinea*, *Lycium afrum*, *Royena hirsuta*, *Carissa Arduina*, *Pteronia paniculata*, *P. pallens*, *Euryops lateriflorus*, *Dodonaea thunbergiana*, *Relbunium squarrosa*, *R. genistaeifolia*, *Metastasia muricata*, and *Chironia baccifera* ranging from one to at most eight or feet in height. The succulent families *Euphorbiaceae*, *Crassulaceae* and *Aizoaceae* all well represented, e.g. *Euphorbia mauritanica*, *E. Mundii*, *E. mammillaris*, *E. clandestina*, *Crassula cultrata*, *Cotyledon decussata*, and *Mesembrianthemum* spp. also *Suaeda fruticosa* and *Salsola foetida*. Travelling northwards *Elytropappus rhinocerotis* becomes much less and eventually almost disappears, and *Salsola aphylla* becomes abundant, forming in places a scrub about eight feet high. Juritz (l.c.) mentions the same feature in the Oudts-Oudtshoorn Division, and states that *Salsola* indicates a lime soil and *Elytropappus* the contrary. Further inland the Renosterbos becomes again common. *Aloe ferox* is here absent and is more plentiful towards van Wyksdorp and the Gouritz River. Specially noteworthy are three arborescent species of *Cotyledon* which are very characteristic of this region, viz. *Cotyledon calceoloides*, *C. paniculata* and a third species undescribed. Outside the limits of the Riversdale Division but in the same region there is a fourth one *C. Wallichii*; and all have very fleshy stems several feet high and deciduous leaves. Many species of *Mesembrianthemum* grow here, most of which are eaten by stock. *Mesembrianthemum junceum* is locally dominant and the ash obtained by burning used to be employed in soap making; in other places *M. cynosum*, *M. subincanum* or *M. appendiculatum*. There are again patches of *Pteronia pallens* and *P. paniculata*, and a valuable stock plant *Pentzia virgata* is abundant. Other shrubs are *Galenia africana* (sometimes dominant), *Aster filifolius*, *Chrysocoma*

*tennifolia* (abundant), *Helichrysum Zeyheri*, *Eriocephalus umbellatus*, *Berkheya cuneata* and *Othonna carnosa*. *Othonna auriculacifolia* and *O. Gymnodiscus* are two species with greatly enlarged roots. The only tallish shrub here is *Euclea undulata* growing sparsely on the plains, more on the hills and most of all near the base of the Langebergen. The time of flowering in the Klein Karoo is more or less irregular, and many species flower after rains, but September is the principal flowering month.

## 2. On the hills.

Here as in the case of the Langebergen the vegetation is more luxuriant on the southern aspect. Nearer the Langebergen *Euclea undulata* is the dominant shrub, but some of the hills are thickly covered with *Aloe microstigma*. Many succulents occur such as *Cotyledon decussata*, *C. rhombifolia*, *Crassula perforata*, *C. laticephala*, *C. decipiens*, *C. columnaris* and many other *Crassulaceae*. *Euphorbia Pillansii* is very plentiful in rocky places. *Polygala teretifolia* and *Helichrysum ercismum* are common shrubs. Further inland *Euclea undulata* is still dominant on the hills, with here and there *Carissa Arduina* and *Portulacaria afra* which are rather more frequent on the hills than on the flats. In these arid localities where heat and light intensity are great, much of the remaining vegetation, even succulents of the most xerophytic type like *Haworthia viscosa*, tends to concentrate itself under the miserable shrubs for shade, and it is there that the local guides in charge of the stranger first look for plants, or in the shelter of rocks. The genus *Gasteria*, represented here by *G. lingua* and *G. subnigricans* variety *glabrior*, is fond of shade. The more tender succulents like *Haworthia altilinea* are always found there, and so is frequently *Eriospermum parvifolium*. Other important species not already mentioned are *Crassula arborescens* (with a fleshy stem one to six feet high), *Crassula radicans*, *Cotyledon reticulata*, *C. paniculata*, *C. heterophylla*, *Sarcocaulon Burmanni*, *Anacampseros telephiumstrum*, *A. filamentosa*, *Aloe variegata* (hills and plains), *A. striata* (hills and plains, and *A. Muirii* (hills on borders of Klein Karoo in Riversdale and Ladismith). *Cheilanthes hirta* variety *contracta* and *Pellaea hastata* are ferns of an advanced xerophytic type. *Ficinia tristachya* and *F. bracteata* are common on the plains and hillsides. Other plants from both regions are classified according to Dr. Marloth's system (Das Kapland, 1908):—

- (a) *Bushes and Dwarf Shrubs*.—*Montinia acris*, *Argyrolobium collinum*, *Indigofera complicata*, *Polygala myrtifolia*, *Rhus longispina*, *R. ercisa*, *Malvastrum divaricatum*, *Royena pallens*, *Jasminum tortuosum* (a scandent plant), *Salvia Muirii*, *Solanum sodomaeum*, *Aptosimum depressum*, *Nemesia foetens*, *Garuleum bipinnatum*, *Osteospermum corymbosum*, *Microlooma sagittatum*, *Salago spuria*, *Lycium afrum*, *L. hirsutum*, *Tetragonia saligna*, *Galenia fruticosa*, *Pharnaceum incanum*, *Hierpicium echinulatum* and *Hyperstelis verrucosa*.
- (b) *Leaf Succulents*.—*Aloe striata*, *A. variegata*, *A. microstigma*, *A. Muirii*, *Haworthia viscosa*, *H. altilinea*, *Apicra foliolosa*, *A. aspera* (in partial shade), *Mesembrianthemum spinosum* and *M. triticiforme* (both bearing thorns), *M. Englishiae* (and many other species), *Tetragonia echinata*,

*Limeum capense*, *Crassula corymbulosa*, *C. pyramidalis* (and many others), *Cotyledon* (many species), *Othonna sedifolia*, *O. carnosa*, *Gasteria* spp., *Bulbine mesembrianthemoides*, *Anacampseros telephiastrum*, *A. papyracea* and *A. filamentosa*.

- (c) *Stem succulents*.—*Trichocaulon piliferum*, *Euphorbia* spp., *Stapelia rufa*, *S. Asterias*, *S. gemmiflora*, *Caralluma ramosa*, *Senecio articulatus*, *Pelargonium tetragonum*, *Sarcocaulon Burmanni* (stems covered with wax), *Piранthus Pillansii*, and many other species.
- (d) *Grasses*.—The commonest grasses in this area grow in separate tufts and are *Brizopyrum capense*, *Themeda Forskalii*, *Fingerhutia africana*, *Cynodon incompletus*, *Schismus fasciculatus*, *Lasiochloa longifolia*, *Ehrharta* spp., and *Eragrostis truncata*, in addition to the ruderal species found near the limited areas of cultivation such as *Aira caryophylla* and *Hordeum secalinum*.
- (e) *Annuals*.—Besides the usual annuals of cultivation and annual grasses there are *Amellus microglossus*, *Relbania sessiliflora*, *Tribulus terrestris*, *Ursinia annua*, *Sutera antirrhinoides*, *Helichrysum capillaceum*, *Oligocarpus calendulaceus*, *Crassula caerulescens* and other species.

Annuals are to some extent an index to aridity, becoming in any region more prominent according to increased dryness.

- (f) *Geophytes*.—Using the term “geophyte” to include also *Liliaceae*, *Amaryllidaceae* and *Iridaceae* this class is well represented:—*Ornithoglossum glaucum*, *Ornithogalum ornatum* (and other spp.), *Veltheimia Deasii*, *Lachenalia unicolor*, *Massonia latifolia*, *Eriospermum parvifolium* (and other spp.), *Gethyllis* spp., *Buphane disticha*, *Moraea polystachya*, *Homeria lilacina* and *Syringodea filifolia*. *Compositae* are represented by *Othonna auriculacifolia*, and *O. Gymnodiscus*. The large swollen base of *Pachypodium succulentum* (*Apocynaceae*) becomes often after decay the nest of bees. Some of the tuberous underground storage organs of *Asclepiadaceae* formed the food of nomadic Bushmen, and are even to-day eaten by children. The aboriginal natives of semi-desert regions could support life largely by a knowledge of its strange, highly specialised vegetation. *Euphorbia Susan-nae* has also a large underground root. Few orchids are found here, *Holothria secunda* growing in the shade of shrubs being an exception.

*Vegetation of the “Quartz” Fields, and Mimetic Plants*.—The “quartz” fields already mentioned show an interesting vegetation which is largely peculiar to them. They are in many cases quite bare of plants, especially when situated away from the mountains. Usually, however, *Elytropappus rhinocerotis* and *Pteronia pallens* grow sparsely on them and some shrubby species of *Aizoaceae*. Other plants found here are *Euphorbia Susan-nae*, *Crassula*

*laticephala*, *C. columnaris* (occasionally) and *Syringodea filifolia*. They are chiefly remarkable for many "mimicry plants," and acaulescent and short stemmed species of *Aizoaceae*. *Gibbaeum album* is the commonest with grey "corpuscula" and white or pink flowers, and another mimetic is *Argeta petrensis*. *Rimaria Heathii*, which consists of many sub-globose grey growths one to two inches in diameter bearing white flowers, is abundant on many of these patches. Other species of *Gibbaeum* such as *G. pubescens*, *G. angulipes*, *G. molle* (usually), *G. pilosulum* (sometimes), *G. dispar* (sometimes) and *G. gibbosum* (frequently) grow here, some of them, however, beyond our limits. *Mentocalyx Muiri*, *Rhinephyllum Muiri* (sometimes) and *Muiria Hortenseae* are also found here.

This "mimicry" has apparently no zoological reason for its existence. It does not prevent the plants being discovered and eaten by herbivora. The writer in the early morning has disturbed troops of baboons (*Papio porcarius*) feeding on them, and Dinter has made a similar observation in South-West Africa (Berger Mesem. und Port, p. 12). Ostriches also eat them and it is impossible that hares, goats, antelopes and other herbivora do not see them more easily than the botanical collector. Mimicry is not confined to plants growing on the quartz fields. *Gibbaeum molle* has "corpuscula" which are sometimes green, but often show a reddish tinge, and when growing on the Bokkeveld shales adjoining the white quartz it closely imitates the latter. When *Rhinephyllum Muiri* occurs on the shales its resemblance makes detection difficult, but on the quartz it is fairly easy to discover. The same is also true of *Gibbaeum dispar*, which grows in similar places with various species of *Glottiphylla*. *Gibbaeum Shandii* occurs chiefly on the shales, rarely on the quartz, and *G. pubescens* on the quartz.

A small *Conophytum*, possibly *C. Muirii*, with corpuscula only one-twelfth to one-eighth inch in diameter, grows also on the shales very frequently. This region of the Klein Karoo proved to be the headquarters of the genus *Gibbaeum* just as Namaqualand is for *Cheiridopsis*; but outliers have been found on the "White Band" near Matjesfontein by Professor Compton, in the Ceres Karoo by Dr. Marloth, and in the Oudtshoorn Karoo by the writer, the latter being a continuation of the Klein Karoo.

The great majority of quartz fields in the Klein Karoo are, however, barren of mimetic plants.

The species of the section *Microphylla* of *Mesembrianthemum* are partial to the quartz fields, but are also, as far as the Riversdale Division is concerned, found on shales as well. *Anacampseros papyracea* also occurs here.

Lichens are abundant in places in rock crevices and on rock surfaces, as well as the xerophytic mosses *Enthosthodon plagiotomus* and *Pterygoneuron macleianum*, the latter a rare species. The presence of lichens and mosses, which show grey or yellowish-grey at a distance, is often an indication of the likelihood of *Conophytums*

being found there. When soil has drifted in, and conditions are somewhat stabilised, *Helichrysium capillaceum* and *Crassula caeruleascens* often come in and form the next stage. *Rhynophyllum Muiri*, small plants of *Gibbacum Shandii* and *Glottiphyllum arrectum* soon follow.

Thorny species in the Klein Karoo are very numerous, and belong to widely separate families. The chief are *Mesembrianthemum spinosum*, *M. triticiforme*, *Euphorbia Pillansii*, *E. cnopla*, *E. mamillaris*, *E. heptagona*, *E. multiceps*, *Cotyledon reticulata*, *Sarcocaulon Burwanni* (*Geraniaceae*), *Solanum sodomaeum*, *Pachypodium succulentum* and *Carissa Arduina* (both *Apocynaceae*), *Rhus longispina* (*Anacardiaceae*), *Lycium afrum* and *L. hirsutum* (*Solanaceae*), *Asparagus* spp. (*Liliaceae*), *Acacia karoo* (*Leguminosae*). Finally some of the succulent stemmed *Asclepiads* have bristles or teeth, e.g., *Trichocaulon piliferum*, and *Stapelia gemmiflora*.

### 3. River Banks and Watercourses.

Along the river courses the trees are larger, the chief being *Acacia karoo*, which lines the banks, often with *Viscum rotundifolium* parasitic on it. *Pappia capensis* and *Rhus lancea* are common small trees here. The commonest shrubs are *Lycium arenicolum*, *L. hirsutum*, *Galenia africana*, *Conyza ivacfolia*, *Suaeda fruticosa*, *Melanthus comosus*, *Zygophyllum* spp., *Royena pallens*, *Nicotiana glauca*, and *Asclepias fruticosa*. *Ballota africana* is a common herb under *Acacia karoo*, and in bare places on the banks. In the river beds *Frankenia pulverulenta* and *Juncus acutus* are abundant. Further away on the shelving slopes or rocks are found *Schotia speciosa*, *Nymmania capensis*, *Salsola aphylla*, *Rhigozum obovatum*, and *Cussonia spicata*.

*Rhigozum obovatum*, the above-mentioned *Schotia*, *Acacia karoo*, and *Pappia capensis* occur also away from the rivers, but then usually in places where water runs rarely after rains.

No *Proteaceae*, *Ericaceae* nor *Restionaceae* were found in this Bokkeveld area of the Klein Karoo. These three families, however, reappear on the Table Mountain Series and Witteberg Series in the portions of the region outside the limits of the Riversdale Division. *Sideroxylon inerme* was not seen.

## V. AQUATIC AND MARSH VEGETATION.

Hydrophytes and helophytes are here considered together. The vegetation of the halophilous marshes, the hygrophilous belt in the forest, and the stream banks in the mountain ravines have already been described. In the valley basin of the Uitenhage Series the rivers form fair-sized ponds or "seekoegate" and marshes. The water is fresh not brackish, and stagnant or very slow flowing. The deeper portions are permanent, but other places are periodically dry. One description will therefore not apply to all these localities. The vegetation is zonally arranged:—

### 1. Submerged Aquatics.

*Chara Kraussii*, *Nitella dregcana*, *Tolypella* sp., *Potamogeton pectinatum*, *Scirpus fluitans*, *S. tenuissimus*, *Zannichellia palustris*.

## 2. Floating Aquatics.

These are usually but not always found in shallower water, e.g., *Lemna gibba* and *Wolffia* sp., the latter forming an extensive green scum on ponds near Riversdale. Others have roots in the mud at the bottom, such as *Nymphaea stellata*, *Limnanthemum thunbergianum*, *Aponogeton distachyon*, *A. spathaceum*, *Limosella grandiflora*, *L. capensis* and *Marsilia macrocarpa*.

## 3. Pronium Palmita Zone.

This, the "palmiet," follows the above aquatic stages in the larger pools. It rises sharp and sheer from the water, and fills up completely channels of the rivers so that the course of the Molen River, for example, can only be detected to-day by its presence. In places this zone is very pure and extensive, but where the ponds are small or the ground marshy only, this stage may be omitted altogether.

## 4. Phragmites communis Zone.

This zone is very frequent in our vleis and also in our rivers. In the larger marshes it is rarely found pure, and combinations of *Phragmites communis* and *Pronium Palmita*, or the former and *Typha australis* frequently occur. *Arundo donax* is found here sometimes but has invariably been planted. Along the rivers where the current flows faster the *Phragmites* zone is often pure and distinct, and the zone of tall *Cyperaceae* is then sometimes further from the shore than the *Phragmites* zone. Exact delimitation is made impossible by *Phragmites* often occurring in fairly dry places, where it is possible to walk through and around it at any season. At the junction of this and the next zone *Wachendorfia thyrsiflora*, six feet high and bearing yellow flowers, is common near the Langebergen. Among the tangle of "palmiet" trunks earth has accumulated and some ferns find a footing, viz., *Pellaea viridis*, *Dryopteris Thelypteris*, *Adiantum Capillus-Veneris*, *A. thalictroides* and *Blechnum capense*.

## 5. Tall Cyperaceae Zone.

This comprises *Cyperus textilis*, *C. denudatus*, *C. fastigiatus*, *C. sphacrospermus*, *Scirpus littoralis*, and *Mariscus riparius*. They form a green area between the previous zone and the shore. This is sometimes dry in summer, or partially so, leaving mud and shallow pools.

## 6. Smaller Cyperaceae Zone.

The previous zone usually grows in water, and can only be reached by wading. It is possible to get nearly all the plants in the present zone dryshod. Many species are common to it and the following section, owing to the vleis being periodical. Discrepancies, which are apparent only, easily arise therefore when lists of such plants are compiled. Here are found *Nasturtium officinale*, *Limosella grandiflora*, *L. capensis*, *Mentha aquatica*, *M. longifolia*, *Ilysanthes riparia*, *Apium graveolens*, *Sium Thunbergii*, *Juncus lomatosphyllus*, *J. capensis*, *J. sonderianus*, *J. exsertus*, *Ianthe aquatica*,



*Gunnera perpersa*, *Dipidax triquetra*, *Crassula natans*, *C. inanis*, *Xyris capensis*, *Marsilia macrocarpa*, *Utricularia capensis*, *U. Ecklonii*, *Triglochin striatum*, *Laurembergia repens*, *Veronica anagallis*, *Samolus porosus*, *S. Valcrandi* (these also in halophilous marshes), *Ursinia incisa*, *Ursinia* n. sp. Muir 1467, *Ellecocharis limosa*, *E. palustris*, *Scirpus prolifer*, *S. rivularis*, *S. verrucosulus*, *S. cernuus*, *S. nodosus*, *S. diabolicus*, *S. paludicola*, *Carex glomerata*, *Fuirena hirta*, *Polygonum serrulatum*, *P. tomentosum* and *P. acuminatum*. These species of *Polygonum* occur in the next zone as well.

## 7. Zone of Vlei Grasses.

Here the ground is damp only, but may occasionally be inundated. The most important species found here are given in the following list:—

Gramineae: *Pennisetum Thunbergii*, *P. macrourum*, *Poa annua*, *Panicum Crus-galli*, *Digitaria ciliaris*, *Eragrostis curcula*, *Rottboellia compressa*, *Polygonum monspeliensis*, *Diplachne fusca*, *Sporobolus indicus* (sometimes submerged by flood waters), *Setaria* spp. (often found in quite dry places, however), *Stenotaphrum glabrum*, *Cynodon Dactylon*, *Briza maxima* and *B. minor*.

Cyperaceae: *Pycreus umbrosus*, *P. polystachyus*, *Scirpus Ludwigii*, *Kyllinga erecta* and *Ficinia striata*.

Restionaceae: *Elegia asperiflora*.

Araceae: *Zantedeschia aethiopica*.

Juncaceae: *Juncus bufonius*.

Iridaceae: *Watsonia augusta*, *W. humilis*, *Aristea ensiformis*, *Gladiolus tristis*.

Liliaceae: *Ornithogalum thyrsoides*, *Kniphofia alooides*,

Orchidaceae: These are the common "vlei orchids" and are well represented, viz., *Satyrium ligulatum*, *S. stenopetalum*, *Monadenia micrantha*, *Orthopenthea bivalvata*, *Disa uncinata*, *Disperis Bolusii* and others.

Ranunculaceae: *Ranunculus capensis*, *R. pinnatus*.

Polygonaceae: *Rumex ecklonianus*, *Polygonum* spp.

Droseraceae: *Drosera* spp.

Crassulaceae: *Crassula Vaillantii*.

Leguminosae: *Psoralea capitata*, *P. pinnata*, *Hallia* spp.

Geraniaceae: *Pelargonium grossularioides*, *Geranium canescens*.

Euphorbiaceae: *Acalypha decumbens*.

Oenotheraceae: *Epilobium hirsutum*, *E. tetragonum*, *Oenothera odorata*.

Halorrhagidaceae: *Laurembergia repens*.

Umbelliferae: *Hydrocotyle asiatica*, *H. verticillata* (also in previous zone).

Primulaceae: *Anagallis Huttoni*.

Ericaceae: *Erica racemosa* (frequent) and *E. quadrangularis*.

Gentianaceae: *Sebaea albens*, *S. minutiflora* (both bearing white flowers), *S. scabra* often forming yellow carpets.

- Asclepiadaceae: *Glossostephanus linearis*, a twining plant.  
 Convolvulaceae: *Falkia repens* (also in dry places).  
 Scrophulariaceae: *Melasma sessiliflorum*.  
 Plantaginaceae: *Plantago* sp. Muir 2815, probably new, is very common.  
 Campanulaceae: *Monopsis lutea*, *M. scabra*, *Lobelia corymbosa*, *Lobelia filicaulis* (also in wet places), *L. anceps*, *Wahlenbergia procumbens*.  
 Compositae: *Cotula coronopifolia*, *C. filifolia*, *Venidium discolor*, *Conyza incisa*, *C. pinnatifida*, *Pulicaria capensis*, *Ursinia scapiformis*, *Senecio erubescens*, *S. purpureus*, *S. halimifolius*, *S. lanceus*.

## 8. Zone of Hygrophilous Trees and Shrubs.

This zone is further away from the water. The trees are *Salix capensis*, *S. babylonica*, and *Populus canescens*, the last named forming woods and later islands in every large vlei in the district. The principal shrubs are *Psoralea bracteata*, *P. pinnata*, *Crotalaria capensis* (often in drier places also), *Borbonia lanceolata*, *Lebeckia simsiana*, *Lessertia stenoloba*, *L. linearis*, *Myrica conifera*, *M. quercifolia*, *Cliffortia strobilifera* (also in the "palmiet" zone), *Penaea myrtoides*, *Malvastrum virgatum*, *Selago glomerata*, *Struthiola hirsuta* (frequent), *Freylinia oppositifolia*, *Heteromorpha arborescens*, *Noltea africana*, *Artemisia afra*, and *Conyza ivaeifolia*. *Rubus pinnatus* and *R. rigidus* grow diffusely, and often form a tangle in this zone. *Eucomis nana* is common.

The arrangement of the above has been adapted from Professor Bews (Plant Ecology of South Coast of Natal, 1920).

In wet places at the northern base of the Langebergen *Mariscus tabularis*, *Scirpus rivularis*, *Fuirena hirta*, and *Ficinia setiformis* are common *Cyperaceae*, and *Phragmites communis* is again abundant. *Hypocalyptus obovatus* and *Psoralea pinnata* grow here, and are tall shrubs.

## PARASITES.

The following occur in Riversdale:—

*Viscum* (3), *Thesium* (22), *Thesium* (4), *Cytinus dioicus*, *Hydnora africana*, *Cassytha ciliolata*, *Cuscuta africana*, *C. appendiculata*, *Hypochaeris sanguinea*, *H. rubra*, *Harveya* (6), *Orobancha ramosa*, *Melasma sessiliflorum*: forty-four in all.

The greater part of the vegetation of the Riversdale Division, especially of the Strandveld and Langebergen, belongs to Cape Flora. It is strongly temperate. The Renosterveld with its succulents has affinities rather with the eastern portion of the Klein Karoo. North of the Langebergen the vegetation is karroid or nearly so, especially in the region further away from the base of the mountains.

## SYSTEMATIC ELEMENTS OF THE FLORA.

Full details will be found in the list of families and genera given at the end. The proportion of genera to species is 1:3.7, and of Monocotyledons to dicotyledons 1:2.6. The total number of species is 2,414, as analysed in Table XVIII.

TABLE XVIII.

	Families.	Genera.	Total Species.	Foreign Species.
Gymnosperms.....	2	2	3	—
Monocotyledons.....	17	189	660	23
Dicotyledons.....	102	455	1,751	97
TOTAL.....	121	646	2,414	120

Cryptogamic plants, not reckoned in the above figures, number fifty.

The number of Phanerogamic species in Riversdale is compared with those of some other regions in Table XIX.

TABLE XIX.

	Area in Square Miles.	Families.	Genera.	Native Species.
Cape Peninsula.....	197	93	485	2,117
Uitenhage and Port Elizabeth...	2,549	129	716	2,203
Riversdale.....	1,711	121	646	2,294
Natal and Zululand.....	29,200	148	901	3 786

In the next table the families in the Riversdale Division are arranged in order of the number of species belonging to each, and compared with similar lists from the Cape Peninsula and Uitenhage (including Port Elizabeth). These two areas have been chosen because the former is on the extreme south-western corner, and the latter near the eastern boundary of the botanical region to which most of the Riversdale Division belongs. Full local floras for the other districts have been published.

TABLE XX.

Riversdale.		Cape Peninsula.		Uitenhage and Port Elizabeth.	
Compositae.....	309	Compositae.....	254	Compositae.....	296
Leguminosae.....	164	Leguminosae.....	156	Liliaceae.....	150
Liliaceae.....	132	Iridaceae.....	119	Leguminosae.....	148
Ericaceae.....	115	Orchidaceae.....	117	Gramineae.....	124
Gramineae.....	109	Cyperaceae.....	115	Cyperaceae.....	80
Iridaceae.....	109	Ericaceae.....	112	Aizoaceae.....	79
Aizoaceae.....	107	Gramineae.....	95	Orchidaceae.....	70
Orchidaceae.....	92	Aizoaceae.....	91	Iridaceae.....	67
Cyperaceae.....	90	Restionaceae.....	89	Crassulaceae.....	63
Crassulaceae.....	72	Liliaceae.....	83	Asclepiadaceae.....	65
Scrophulariaceae.....	69	Geraniaceae.....	65	Scrophulariaceae.....	62
Restionaceae.....	65	Scrophulariaceae.....	60	Enphorbiaceae.....	52
Proteaceae.....	59	Campululaceae.....	59	Amarylhidaceae.....	43
Thymelaeaceae.....	49	Proteaceae.....	47	Geraniaceae.....	40
Campululaceae.....	44	Crassulaceae.....	40	Labiatae.....	40
Rutaceae.....	42	Umbelliferae.....	38	Ericaceae.....	39

The new genera split off from *Mesembrianthemum* have not been given separately as that work is not yet completed; and comparison is easier with the other lists in which it was also not done.

*Families* represented by not more than five species; the first figure gives the number of genera, the second that of the species:—

Pinaceae 1.1; Taxaceae 1.2; Typhaceae 1.1; Potamogetonaceae 3.3; Aponogetonaceae 1.2; Scheuchzeriaceae 1.2; Aroidaceae 1.1; Lemnaceae 2.2; Xyridaceae 1.1; Commelinaceae 2.2; Piperaceae 1.2; Salicaceae 1.1; Myricaceae 1.5; Ulmaceae 1.1; Urticaceae 5.5; Lorantheae 1.3; Grubbiaceae 1.2; Cytinaceae 1.1; Hydnoraceae 1.1; Amarantaceae 2.4; Phytolaccaceae 2.3; Nymphaeaceae 1.1; Menispermaceae 1.1; Lauraceae 2.2; Papaveraceae 4.5; Capparidaceae 1.1; Resedaceae 1.2; Droseraceae 1.4; Saxifragaceae 1.1; Pittosporaceae 1.1; Cunoniaceae 2.2; Linaceae 1.3; Meliaceae 2.2; Aquifoliaceae 1.1; Icacinaceae 2.2; Sapindaceae 2.2; Melianthaceae 1.2; Vitaceae 1.3; Tiliaceae 2.2; Guttiferae 1.2; Elatinaceae 1.1; Frankeniaceae 1.2; Violaceae 1.1; Flacourtiaceae 2.4; Cactaceae 1.3; Penaeaceae 2.5; Geissolomaceae 1.1; Oliniaceae 1.1; Myrtaceae 1.1; Oenotheraceae 2.3; Halorrhagidaceae 2.2; Araliaceae 1.2; Cornaceae 1.1; Myrsinaceae 2.2; Sapotaceae 1.1; Oleaceae 2.5; Salvadoraceae 1.1; Loganiaceae 2.2; Apocynaceae 2.2; Bignoniaceae 1.1; Pedaliaceae 1.1; Orobanchaceae 1.1; Lentibulariaceae 1.2; Myoporaceae 1.1; Plantaginaceae 1.5; Dipsaceae 1.1; Goodeniaceae 1.1.

Genera with more than 15 species:—

Scirpus 9; Ficinia 22; Restio 18; Gladiolus 18; Satyrium 18; Disa 18; Protea 19; Leucadendron 17; Thesium 22; Mesembrianthemum 92; Crassula 56; Cliffortia 16; Psoralea 16; Aspalathus 44; Indigofera 17; Pelargonium 36; Oxalis 23; Agathosma 17; Muraltia 17; Euphorbia 25; Hermannia 30; Gnidia 19; Erica 89; Sebaea 16; Selago 18; Sutura 18; Ursinia 17; Helichrysus 38; Senecio 47.

*Distribution of Families and Genera with Special Reference to Riversdale.*

The lists here given afford comparison with the floras of the Cape Peninsula and Uitenhage plus Port Elizabeth; and will serve to some extent to show how far that of Riversdale is being affected by the extension of species from the east and west.

(1) The following are present in Riversdale, but up to the present are apparently not mentioned from the Cape Peninsula:—

(a) Families: *Capparidaceae*, *Pittosporaceae*, *Guttiferae*, *Goodeniaceae*, *Salvadoraceae*, *Apocynaceae*, *Myrtaceae*, *Acanthaceae*, *Loganiaceae*, *Pedaliaceae*, *Geissolomaceae*, *Bignoniaceae*, *Meliaceae*.

(b) Genera: *Anacampseros*, *Sphaeralcea*, *Sida*, *Abutilon*, *Pavonia*, *Euchaetis*, *Acmadenia*, *Empleurum*, *Clausena*, *Rhamnus*, *Nymania*, *Dodonaea*, *Laurophyllus*, *Coelidium*, *Hypocalyptus*, *Loddigesia*, *Calpurnia*, *Schotia*, *Kalanchoe*, *Linconia*, *Citrullus*, *Hyperstelis*, *Alepidca*, *Rhyticarpus*, *Heteromorpha*, *Galopina*, *Gardenia*, *Gymnostephium*,

*Garuleum*, *Heterolepis*, *Coilostigma*, *Thoracosperma*, *Platycalyx*, *Anomalanthus*, *Aniserica*, *Leptericia*, *Jasminum*, *Glossostephanus*, *Sarcostemma*, *Fockea*, *Caralluma*, *Anchusa*, *Aptosimum*, *Plectranthus*, *Teucrium*, *Nivenia*, *Lasiosiphon*, *Phyllanthus*, *Acalypha*, *Platanthera*, *Lanaria*, *Syringodea*, *Klattia*, *Freesia*, *Gasteria*, *Haworthia*, *Apicra*, *Allium*, *Massonia*, *Eucomis*, *Veltheimia*, *Cyanotis*, *Trachypogon*, *Tricholaena*, *Fingerhutia*, *Triraphis*, *Kyllinga*, etc.

(2) The following are apparently not recorded from Riversdale but are present in the Cape Peninsula:—

- (a) Families: All families found in the Cape Peninsula are also found in Riversdale.
- (b) Genera: *Chamira*, *Carponema*, *Macrostylis*, *Euchlora*, *Fagelia*, *Grielum*, *Audouinia*, *Hymenogynce*, *Coclanthium*, *Nenax*, *Anaxeton*, *Bryomorphe*, *Osmitopsis*, *Otochlamys*, *Grisebachia*, *Sympieza*, *Salaris*, *Eustegia*, *Agathelpis*, *Cryptadenia*, *Sarcocolla*, *Brachysiphon*, *Sparaxis*, *Synnotia*, *Crinum*, *Hyacinthus*, *Ecklonia*, *Prionanthium*, *Chaetobromus* and others.

(3) The following are present in Riversdale, but apparently not yet recorded from Uitenhage:—

- (a) Families: *Orobanchaceae*, *Pedaliaceae*, *Myoporaceae*, *Geissolomaceae*, and *Hydnoraceae* (all small and monogeneric). *Proteaceae*, *Restionaceae* and *Ericaceae* are more numerous in Riversdale, but *Amaryllidaceae*, and the tropical families *Euphorbiaceae*, *Asclepiadaceae*, *Labiatae* and *Acanthaceae* more strongly represented in Uitenhage.
- (b) Genera: *Anemone*, *Sphaeralcea*, *Euchaetis*, *Hartogia*, *Liparia*, *Coelidium*, *Hypocalyptus*, *Loddigesia*, *Raspalia*, *Staavia*, *Linconia*, *Metrosideros*, *Mairea*, *Gymnostephium*, *Garuleum*, *Hippia*, *Phacnoma*, *Osmites*, *Microdon*, *Phillipia* (and other minor genera of *Ericaceae*), *Caralluma*, *Orphium*, *Teedia*, *Brabeium*, *Aulax*, *Mimetes*, *Serruria*, *Spatalla*, *Arthrosolen*, *Thesidium*, *Pachites*, *Orthopenthea*, *Dilatris*, *Klattia*, *Lapeyrousia*, *Pauridia*, *Amaryllis*, *Bulbinella*, *Baeometra*, *Willdenowia*, etc., etc.

(4) The following are apparently not recorded from Riversdale but are present in Uitenhage:—

- (a) Families: *Cycadaceae*, *Hydrochoritaceae*, *Dioscoraceae*, *Musaceae*, *Callitrichaceae*, *Balsaminaceae*, *Ochnaceae*, *Combretaceae*, *Gesneraceae*, *Valerianaceae*, etc.
- (b) Genera: *Sansevieria*, *Apodolirion*, *Behnia*, *Dracacna*, *Dierama*, *Polystachya*, *Listrostachys*, *Mystacidium*, *Fleurya*, *Pupalia*, *Capparis*, *Maerua*, *Buchenroedera*, *Eriosema*, *Erythrina*, *Vigna*, *Toddalia*, *Clerodendron*, *Ekebergia*, *Croton*, *Jatropha*, *Harpephyllum*, *Smelocphyllum*, *Melhania*, *Dombeya*, *Trimeria*, *Nuria*, *Strychnos*, *Akocanthera*, *Raphionacme*, *Tylophora*, *Ipomaea*, *Sopubia*, *Loranthus*, *Isoglossa*, *Mikania*, *Othonnopsis*, *Didelta*, *Erianthus*, *Arundinella* and others.

## LIST OF FAMILIES AND GENERA.

	Total.	Foreign.		Total.	Foreign.
<b>Pteridophyta (50)—</b>			<b>Gramineae (109) (continued)—</b>		
<b>Filices (45)—</b>			Koeleria.....	2	—
Hymenophyllum.....	2	—	Avenastrum.....	2	—
Hemitelia.....	1	—	Avena.....	2	2
Dryopteris.....	2	—	Pentaschistis.....	7	—
Polystichum.....	3	—	Pentameris.....	2	—
Asplenium.....	8	—	Danthonia.....	8	—
Ceterach.....	1	—	Arundo.....	1	1
Blechnum.....	4	—	Phragmites.....	1	—
Pellaea.....	3	—	Polypogon.....	1	1
Adiantopsis.....	1	—	Agrostis.....	1	—
Cheilanthes.....	2	—	Aristida.....	3	—
Hypolepis.....	2	—	Stipa.....	2	—
Adiantum.....	2	—	Tragus.....	1	—
Pteris.....	2	—	Sporobolus.....	2	—
Pteridium.....	1	—	Diplachne.....	1	—
Histiopteris.....	1	—	Eragrostis.....	8	—
Vittaria.....	1	—	Cynodon.....	2	—
Polypodium.....	2	—	Chloris.....	1	—
Elaphoglossum.....	2	—	Triraphis.....	1	—
Gleichenia.....	1	—	Ehrharta.....	10	—
Schizaea.....	1	—	Phalaris.....	2	2
Mohria.....	1	—	Melica.....	1	—
Todea.....	1	—	Fingerhutia.....	1	—
Osmunda.....	1	—	Schismus.....	1	—
Rhizocarpeae (1) —			Lasiachloa.....	2	—
Marsilia.....	1	—	Brizopyrum.....	1	—
<b>Lycopodiaceae (3)—</b>			Briza.....	2	2
Lycopodium.....	3	—	Poa.....	2	1
Selaginellaceae (1) —			Festuca.....	1	—
Selaginella.....	1	—	Vulpia.....	1	1
<b>Gymnospermae (3)—</b>			Bromus.....	4	4
Pinaceae (1)—			Brizopodium.....	1	1
Widdringtonia.....	1	—	Lolium.....	1	1
Taxaceae (2)—			Agropyrum.....	1	—
Podocarpus.....	2	—	Hordeum.....	2	2
Angiospermae—			Bambusa.....	1	1
Monocotyledoneae (660) —			Zea.....	1	1
Typhaceae (1) —			<b>Cyperaceae (90)—</b>		
Typha.....	1	—	Kyllinga.....	1	—
Potamogetonaceae (3)—			Pycnus.....	2	—
Zannichellia.....	1	—	Cyperus.....	6	—
Zostera.....	1	—	Juncellus.....	1	—
Potamogeton.....	1	—	Mariscus.....	4	—
Aponogetonaceae (2) —			Bulbostylis.....	2	—
Aponogeton.....	2	—	Eleocharis.....	2	—
Scheuchzeriaceae (2)—			Scirpus.....	19	—
Triglochin.....	2	—	Ficinia.....	22	—
<b>Gramineae (109)—</b>			Fuirena.....	1	—
Rothboellia.....	1	—	Rhynchospora.....	1	—
Trachypogon.....	1	—	Carpina.....	3	—
Pollinia.....	1	—	Schoenus.....	1	—
Andropogon.....	4	—	Epischoenus.....	1	—
Themeda.....	1	—	Tetraria.....	15	—
Paspalum.....	1	1	Macrochaetium.....	1	—
Digitaria.....	2	—	Chrysithrix.....	3	—
Panicum.....	4	1	Schoenoxiphium.....	3	—
Setaria.....	3	—	Carex.....	2	—
Pennisetum.....	3	—	<b>Aroidaceae (1)—</b>		
Stenotaphrum.....	1	—	Zantedeschia.....	1	—
Tricholaena.....	1	—	<b>Lemnaceae (2)—</b>		
Achneria.....	1	—	Lemna.....	1	—
Aira.....	1	1	Wolffia.....	1	—
Holcus.....	1	—			

	Total.	Foreign.		Total.	Foreign.
<b>Restionaceae (65)—</b>			<b>Amaryllidaceae (31) (<i>continued</i>)—</b>		
Restio.....	18	—	Nerine.....	1	—
Dovea.....	5	—	Haemanthus.....	5	—
Elegia.....	11	—	Buphane.....	2	—
Leptocarpus.....	5	—			
Thamnochortus.....	8	—	<b>Iridaceae (109)—</b>		
Staberoha.....	2	—	Moraea.....	10	—
Hypolaena.....	2	—	Homocria.....	4	—
Hypodiscus.....	6	—	Galaxia.....	1	—
Cannomois.....	2	—	Ferraria.....	1	—
Willdenowia.....	5	—	Hexaglottis.....	1	—
Anthochortus.....	1	—	Syringodea.....	1	—
<b>Xyridaceae (1)—</b>			Romulea.....	9	—
Xyris.....	1	—	Bobartia.....	5	—
<b>Commelinaceae (2)—</b>			Aristea.....	8	—
Commelina.....	1	—	Klattia.....	1	—
Cyanotis.....	1	—	Hesperantha.....	5	—
<b>Liliaceae (132)—</b>			Geissorhiza.....	7	—
Asparagus.....	9	—	Ixia.....	5	—
Kniphofia.....	2	—	Lapeyrouisia.....	3	—
Gasteria.....	4	—	Micranthus.....	1	—
Apiera.....	2	—	Freesia.....	2	—
Aloe.....	12	—	Watsonia.....	5	—
Haworthia.....	10	—	Babiana.....	4	—
Bulbinella.....	1	—	Melaspheerula.....	1	—
Bulbine.....	11	—	Tritonia.....	8	—
Eriospermum.....	9	—	Acidanthera.....	3	—
Anthericum.....	6	—	Gladiolus.....	18	—
Chlorophytum.....	2	—	Antholyza.....	6	—
Agapanthus.....	1	—			
Tulbaghia.....	2	—	<b>Orchidaceae (92)—</b>		
Allium.....	1	—	Aerolophia.....	3	—
Massonia.....	3	—	Eulophia.....	5	—
Polyxena.....	1	—	Angraecum.....	1	—
Lachenalia.....	13	—	Platanthera.....	1	—
Drimia.....	2	—	Bartholina.....	2	—
Dipcadi.....	2	—	Holothrix.....	7	—
Albuca.....	8	—	Habenaria.....	1	—
Urginea.....	3	—	Bonatea.....	1	—
Veltheimia.....	2	—	Satyrum.....	18	—
Eucomis.....	1	—	Avicaps.....	1	—
Scilla.....	3	—	Pachites.....	2	—
Ornithogalum.....	15	—	Orthopenthea.....	3	—
Androcymbium.....	2	—	Menadenia.....	4	—
Wurmbea.....	1	—	Herschelia.....	3	—
Baeometra.....	1	—	Penthea.....	2	—
Dipidax.....	2	—	Disa.....	18	—
Ornithoglossum.....	1	—	Schizodium.....	2	—
<b>Juncaceae (11)—</b>			Ceratandra.....	1	—
Juncus.....	10	—	Ceratandropsis.....	2	—
Prionium.....	1	—	Ommatodium.....	1	—
<b>Haemodoraceae (7)—</b>			Pterygodium.....	5	—
Wachendorfia.....	2	—	Corycium.....	4	—
Dilatris.....	2	—	Disperis.....	5	—
Cyanella.....	2	—			
Lanaria.....	1	—	<b>Dicotyledoneae (1,751).</b>		
<b>Amaryllidaceae (31)—</b>			<b>Archichlamydeae (998).</b>		
Pauridia.....	1	—	<b>Piperaceae (2)—</b>		
Forbesia.....	1	—	Peperomia.....	2	—
Ianthe.....	5	—	<b>Salicinae (1)—</b>		
Hypoxis.....	4	—	Salix.....	1	—
Hessea.....	2	—	<b>Myricaceae (5)—</b>		
Carpolyza.....	1	—	Myrica.....	5	—
Gethyllis.....	3	—	<b>Ulmaceae (1)—</b>		
Amaryllis.....	1	—	Celtis.....	1	—
Cyrtanthus.....	2	—	<b>Moraceae (1)—</b>		
Brunsvigia.....	3	—	Ficus.....	1	—

	Total. Foreign.			Total. Foreign.	
<b>Urticaceae (5)—</b>			<b>Caryophyllaceae (21) (<i>continued</i>)—</b>		
Urtica.....	1	1	Lepigonum.....	2	2
Cannabis.....	1	1	Polycarpon.....	1	1
Forskahlea.....	1	—	Pollichia.....	1	—
Droguetia.....	1	—	Corrigiola.....	1	1
Australina.....	1	—	Scleranthus.....	1	1
<b>Proteaceae (59)—</b>			Herniaria.....	1	1
Brabeium.....	1	—	<b>Nymphaeaceae (1)—</b>		
Aulax.....	3	—	Nymphaea.....	1	—
Leucadendron.....	17	—	<b>Ranunculaceae (7)—</b>		
Protea.....	19	—	Clematis.....	1	—
Leucospermum.....	7	—	Anemone.....	1	—
Mimetes.....	3	—	Knowltonia.....	3	—
Serruria.....	2	—	Ranunculus.....	2	—
Spatalla.....	3	—	<b>Menispermaceae (1)—</b>		
Nivenia.....	4	—	Antizoma.....	1	—
<b>Loranthaceae (3)—</b>			<b>Lauraceae (2)—</b>		
Viscum.....	3	—	Cassytha.....	1	—
<b>Santalaceae (26)—</b>			Ocotea.....	1	—
Thesium.....	22	—	<b>Papaveraceae (5)—</b>		
Thesidium.....	4	—	Papaver.....	1	1
Osyris.....	1	—	Argemone.....	1	1
<b>Grubbiaceae (2)—</b>			Corydalis.....	2	—
Grubbia.....	2	—	Fumaria.....	1	1
<b>Cytinaceae (1)—</b>			<b>Cruciferae (23)—</b>		
Cytinus.....	1	—	Nasturtium.....	1	1
<b>Hydnoraceae (1)—</b>			Sisymbrium.....	2	—
Hydnora.....	1	—	Senebiera.....	1	1
<b>Polygonaceae (11)—</b>			Capsella.....	1	1
Polygonum.....	5	1	Lepidium.....	4	—
Rumex.....	5	1	Brassica.....	1	1
Emex.....	1	1	Heliohila.....	11	—
<b>Chenopodiaceae (15)—</b>			Rhaphanus.....	1	1
Chenopodium.....	4	4	Brachycarpaea.....	1	—
Roubieva.....	1	1	<b>Capparidaceae (1)—</b>		
Exomis.....	1	—	Cadaba.....	1	—
Chenolea.....	1	—	<b>Resedaceae (2)—</b>		
Atriplex.....	2	2	Reseda.....	2	2
Salicornia.....	3	—	<b>Droseraceae (4)—</b>		
Salsola.....	2	—	Drosera.....	4	—
Suaeda.....	1	—	<b>Crassulaceae (72)—</b>		
<b>Amarantaceae (4)—</b>			Dinacria.....	1	—
Amaranthus.....	3	2	Grammanthes.....	1	—
Achyranthes.....	1	1	Crassula.....	56	—
<b>Phytolaccaceae (3)—</b>			Rochea.....	1	—
Limeum.....	1	—	Cotyledon.....	12	—
Adenogramma.....	2	—	Kalanchoe.....	1	—
<b>Aizoaceae (107)—</b>			<b>Saxifragaceae (1)—</b>		
Hyperstelis.....	1	—	Montinia.....	1	—
Pharnaceum.....	3	—	<b>Pittosporaceae (1)—</b>		
Mesembrianthemum.....	92	—	Pittosporum.....	1	—
Tetragonia.....	5	—	<b>Cunoniaceae (2)—</b>		
Aizoon.....	1	—	Cunonia.....	1	—
Galenia.....	5	—	Platylophus.....	1	—
<b>Portulacaceae (7)—</b>			<b>Bruniaceae (11)—</b>		
Portulaca.....	1	1	Staavia.....	1	—
Portulacaria.....	1	—	Pseudobacoea.....	2	—
Anacampseros.....	5	—	Brunia.....	2	—
<b>Caryophyllaceae (21)—</b>			Berzelia.....	4	—
Dianthus.....	5	—	Raspalia.....	1	—
Silene.....	5	1	Linconia.....	1	—
Agrostemma.....	1	1	<b>Rosaceae (19)—</b>		
Stellaria.....	1	1	Rubus.....	2	—
Cerastium.....	1	—	Alchemilla.....	1	—
Spergula.....	1	1	Cliffortia.....	16	—



	Total. Foreign.			Total. Foreign.	
<b>Leguminosae (164)—</b>			<b>Euphorbiaceae (42)—</b>		
Cyclopia.....	3	—	Euphorbia.....	15	2
Podalyria.....	7	—	Phyllanthus.....	1	—
Liparia.....	3	—	Cluytia.....	10	—
Priestleya.....	4	—	Acalypha.....	1	—
Amphithalea.....	3	—	Ricinus.....	1	1
Coelidium.....	2	—	Adenocline.....	3	—
Borbonia.....	2	—	Leidesia.....	1	—
Rafnia.....	6	—	<b>Anacardiaceae (14)—</b>		
Crotalaria.....	2	—	Laurophyllus.....	1	—
Lotononis.....	7	—	Rhus.....	13	—
Argyrolobium.....	6	—	<b>Aquifoliaceae (1)—</b>		
Melolobium.....	1	—	Ilex.....	1	—
Hypocalyptus.....	1	—	<b>Celastraceae (15)—</b>		
Loddigesia.....	1	—	Putterlickia.....	1	—
Lebeckia.....	5	—	Pterocelastrus.....	2	—
Wiborgia.....	2	—	Gymnosporia.....	6	—
Psoralea.....	16	—	Cassine.....	2	—
Aspalathus.....	44	—	Elaeodendron.....	1	—
Indigofera.....	17	—	Mystroxyton.....	1	—
Trifolium.....	3	2	Lauridia.....	1	—
Melilotus.....	1	1	Hartogia.....	1	—
Medicago.....	3	3	<b>Icacinaeae (2)—</b>		
Vicia.....	1	1	Apodytes.....	1	—
Tephrosia.....	1	—	Cassinopsis.....	1	—
Sutherlandia.....	1	—	<b>Sapindaceae (2)—</b>		
Lessertia.....	4	—	Pappea.....	1	—
Hallia.....	4	—	Dodonaea.....	1	—
Dolichos.....	2	—	<b>Melanthaceae (2)—</b>		
Rhynchosia.....	6	—	Melanthus.....	2	—
Virgilia.....	1	—	<b>Rhamnaceae (18)—</b>		
Calpurnia.....	1	—	Rhamnus.....	1	—
Cassia.....	1	1	Scutia.....	1	—
Schotia.....	2	—	Noitea.....	1	—
Acacia.....	1	—	Phylia.....	15	—
<b>Geraniaceae (42)—</b>			<b>Vitaceae (3)—</b>		
Monsonia.....	2	—	Rhoicissus.....	3	—
Sarcocaulon.....	1	—	<b>Tiliaceae (2)—</b>		
Geranium.....	2	—	Grewia.....	1	—
Erodium.....	2	2	Sparmannia.....	1	—
Pelargonium.....	35	—	<b>Malvaceae (14)—</b>		
<b>Oxalidaceae (23)—</b>			Malva.....	2	2
Oxalis.....	23	—	Malvastrum.....	4	—
<b>Linaceae (3)—</b>			Sphaeralcea.....	1	—
Linum.....	3	—	Lavatera.....	1	1
<b>Zygophyllaceae (8)—</b>			Sida.....	1	—
Tribulus.....	1	1	Abutilon.....	1	—
Zygophyllum.....	7	—	Pavonia.....	1	—
<b>Rutaceae (42)—</b>			Hibiscus.....	3	—
Ruta.....	1	1	<b>Sterculiaceae (30)—</b>		
Euchaetis.....	2	—	Hermannia.....	30	—
Diosma.....	5	—	<b>Guttiferae (2)—</b>		
Colconema.....	1	—	Hypericum.....	2	—
Acmadenia.....	4	—	<b>Elatinaceae (1)—</b>		
Adenandra.....	1	—	Bergia.....	1	—
Barosma.....	8	—	<b>Frankeniaceae (2)—</b>		
Agathosma.....	17	—	Frankenia.....	2	—
Empleurum.....	1	—	<b>Violaceae (1)—</b>		
Clausena.....	1	—	Viola.....	1	1
Fagara.....	1	—	<b>Flacourtiaceae (4)—</b>		
<b>Meliaceae (2)—</b>			Kiggelaria.....	2	—
Melia.....	1	1	Scolopia.....	2	—
Nymania.....	1	—	<b>Cactaceae (3)—</b>		
<b>Polygalaceae (28)—</b>			Opuntia.....	3	3
Polygala.....	10	—			
Mundia.....	1	—			
Muraltia.....	17	—			

	Total. Foreign.			Total. Foreign.	
Penaceae (6)—			Sapotaceae (1)—		
Penaea.....	5	—	Sideroxylon.....	1	—
Endonema.....	1	—	Ebenaceae (9)—		
Geissolomaceae (1)—			Royena.....	5	—
Geissoloma.....	1	—	Euclea.....	4	—
Oliniaceae (1)—			Oleaceae (5)—		
Olinia.....	1	—	Jasminum.....	1	—
Thymelaeaceae (49)—			Olca.....	4	—
Passerina.....	6	—	Salvadoraceae (1)—		
Arthrosolen.....	2	—	Azima.....	1	—
Lachnaea.....	6	—	Loganiaceae (2)—		
Struthiola.....	15	—	Chilianthus.....	1	—
Gnidia.....	19	—	Buddleia.....	1	—
Lasiosiphon.....	1	—	Gentianaceae (27)—		
Myrtaceae (1)—			Sebaea.....	16	—
Metrosideros.....	1	—	Orphium.....	1	—
Oenotheraceae (3)—			Chironia.....	8	—
Oenothera.....	1	1	Villarsia.....	1	—
Epilobium.....	2	2	Limnanthemum.....	1	—
Halorrhagidaceae (2)—			Apocynaceae (2)—		
Gunnera.....	1	—	Carissa.....	1	—
Laurembergia.....	1	—	Pachypodium.....	1	—
Araliaceae (2)—			Asclepiadaceae (28)—		
Cussonia.....	2	—	Secamone.....	1	—
Umbelliferae (31)—			Astephanus.....	1	—
Hydrocotyle.....	5	—	Microloma.....	2	—
Alcipea.....	1	—	Xysmalobium.....	1	—
Apium.....	1	1	Schizoglossum.....	3	—
Trachyspermum.....	1	1	Asclepias.....	4	—
Carum.....	3	1	Pachycarpus.....	1	—
Sium.....	1	—	Glossostephanus.....	1	—
Rhyticarpus.....	1	—	Cynanchum.....	2	—
Bupleurum.....	2	—	Sarcostemma.....	1	—
Heteromorpha.....	1	—	Fockea.....	1	—
Lichtensteinia.....	2	—	Brachystelma.....	1	—
Foeniculum.....	1	1	Caralluma.....	2	—
Cnidium.....	1	—	Stapelia.....	4	—
Pencedanum.....	6	—	Duvalia.....	1	—
Amesorrhiza.....	2	—	Trichocaulon.....	1	—
Arctopus.....	1	—	Piaranthus.....	1	—
Hermas.....	1	—	Convolvulaceae (7)—		
Caucalis.....	1	—	Convolvulus.....	4	—
Cornaceae (1)—			Falkia.....	1	—
Curtisia.....	1	—	Cuseuta.....	2	—
Metachlamydeae (753)—			Boraginaceae (14)—		
Ericaceae (115)—			Echinosperrum.....	1	—
Erica.....	89	—	Cynoglossum.....	1	1
Blacteria.....	5	—	Anehusa.....	1	—
Phillipia.....	1	—	Myosotis.....	2	—
Coilostigma.....	1	—	Lithospermum.....	1	1
Thoracosperma.....	6	—	Lobostemon.....	8	—
Platycalex.....	1	—	Verbenaceae (7)—		
Simoecheilus.....	3	—	Stilbe.....	3	—
Syndesmanthus.....	2	—	Verbena.....	1	1
Anomalanthus.....	4	—	Lantana.....	1	—
Aniserica.....	1	—	Bouchea.....	2	—
Lapterica.....	1	—	Labiatae (16)—		
Scyphogynae.....	1	—	Mentha.....	3	1
Myrsinaceae (2)			Plectranthus.....	1	—
Myrsine.....	1	—	Salvia.....	6	—
Rapanca.....	1	—	Stachys.....	2	—
Primulaceae (4)—			Ballota.....	1	—
Anagallis.....	2	1	Leonotis.....	2	—
Samolus.....	2	—	Teucrium.....	1	—
Plumbaginaceae (2)—					
Statice.....	2	—			

	Total. Foreign.			Total. Foreign.	
<b>Solanaceae (21)—</b>			<b>Cucurbitaceae (6)—</b>		
Solanum.....	9	2	Kedrostis.....	3	—
Physalis.....	1	1	Citrullus.....	1	—
Withania.....	1	1	Cucumis.....	1	—
Nicandra.....	1	1	Melothria.....	1	—
Lycium.....	6	—	<b>Campanulaceae (44)—</b>		
Datura.....	1	1	Grammatotheca.....	1	—
Nicotiana.....	2	2	Monopsis.....	4	—
<b>Selaginaceae (31)—</b>			Lobelia.....	14	—
Hebenstreitia.....	5	—	Laurentia.....	1	—
Dischisma.....	2	—	Lightfootia.....	8	—
Walafrida.....	6	—	Microcodon.....	1	—
Selago.....	18	—	Wahlenbergia.....	7	—
<b>Scrophulariaceae (69)—</b>			Theilera.....	1	—
Aptosimum.....	1	—	Prismatocarpus.....	1	—
Verbascum.....	1	1	Roella.....	2	—
Diascia.....	5	—	Cyphia.....	4	—
Hemimeris.....	2	—	<b>Goodeniaceae (1)—</b>		
Nemesia.....	11	—	Scaevola.....	1	—
Halleria.....	2	—	<b>Compositae (309)—</b>		
Teedia.....	1	—	Corymbium.....	3	—
Freylinia.....	2	—	Amellus.....	2	—
Manulea.....	3	—	Mairea.....	2	—
Sutera.....	18	—	Charieis.....	1	—
Phyllopodium.....	3	—	Gymnostephium.....	1	—
Polycarena.....	1	—	Aster.....	10	—
Zaluzianskya.....	3	—	Erigeron.....	2	2
Limosella.....	2	—	Garuleum.....	1	—
Hysanthes.....	1	—	Chrysocoma.....	1	—
Veronica.....	2	2	Pteronia.....	8	—
Melasma.....	1	—	Conyza.....	4	—
Bopusia.....	1	—	Brachylaena.....	1	—
Harveya.....	6	—	Tarehonanthus.....	1	—
Hyobanche.....	2	—	Pulicaria.....	1	—
<b>Bignoniaceae (1)—</b>			Bidens.....	1	1
Rhigozum.....	1	—	Oedera.....	3	—
<b>Pedaliaceae (1)—</b>			Ursinia.....	17	—
Sesamum.....	1	—	Gamolepis.....	3	—
<b>Orobanchaceae (1)—</b>			Chrysanthemum.....	1	—
Orobanche.....	1	—	Hippia.....	2	—
<b>Lentibulariaceae (2)—</b>			Artemisia.....	1	—
Utricularia.....	2	—	Matricaria.....	2	—
<b>Acanthaceae (9)—</b>			Pentzia.....	3	—
Ruellia.....	1	—	Cotula.....	6	—
Blepharis.....	3	—	Athanasia.....	9	—
Barleria.....	1	—	Erioccephalus.....	2	—
Justicia.....	1	—	Leontonyx.....	3	—
Hypoestes.....	2	—	Helichrysum.....	38	—
Dicliptera.....	1	—	Helipterum.....	5	—
<b>Myoporaceae (1)—</b>			Gnaphalium.....	3	—
Oftia.....	1	—	Metalsia.....	4	—
<b>Plantaginaceae (5)—</b>			Elytropappus.....	2	—
Plantago.....	5	2	Disparago.....	2	—
<b>Rubiaceae (12)—</b>			Stoebe.....	11	—
Burchellia.....	1	—	Ifloga.....	2	—
Gardenia.....	1	—	Phaenocoma.....	1	—
Plectronia.....	2	—	Athrixia.....	2	—
Galopina.....	1	—	Leyssera.....	1	—
Anthospermum.....	3	—	Nestiera.....	1	—
Rubia.....	1	—	Relbania.....	7	—
Carpaeoce.....	1	—	Osmites.....	1	—
Galium.....	2	—	Xanthium.....	1	1
<b>Dipsaceae (1)—</b>			Cineraria.....	6	—
Scabiosa.....	1	—	Othonna.....	14	—
			Gymnodiscus.....	1	—
			Senecio.....	47	1
			Euryops.....	8	—

	Total. Foreign.	
Compositae (300) ( <i>continued</i> )—		
Dimorphotheca.....	4	—
Tripteris.....	5	—
Oligocarpus.....	1	—
Osteospermum.....	8	—
Arctotis.....	5	—
Heterolepis.....	1	—
Venidium.....	2	—
Gorteria.....	1	—
Cryptostemma.....	2	—
Gazania.....	3	—
Haplocarpha.....	1	—
Cullumia.....	4	—
Hirpicium.....	1	—
Berkheya.....	7	—
Stephanocoma.....	1	—
Printzia.....	1	—
Dicoma.....	1	—
Oldenburgia.....	1	—
Gerbera.....	2	—
Centaurea.....	2	2
Picris.....	1	1
Hypochoeris.....	1	1
Sonchus.....	2	1
Tagetes.....	1	1
Cnicus.....	1	1
Hieracium.....	1	—
Lactuca.....	1	—

# **“FOREST-SUCCESSION AND ECOLOGY IN THE KNYSNA REGION”**

(with 30 diagrams and 82 photographs, being the thesis submitted in partial fulfilment of regulations governing the degree of D.Sc. in the University of Edinburgh, 1927).

— BY —

**JOHN F. V. PHILLIPS, D.Sc. (Edin.), F.R.S.E., F.L.S.**

Formerly in Charge Forest Research Station, Deepwalls, Knysna,  
South Africa

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THE GOVERNMENT PRINTER, PRETORIA

1931

## UNION OF SOUTH AFRICA.

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DEPARTMENT OF AGRICULTURE, DIVISION OF PLANT INDUSTRY.

590, Vermeulen Street, Pretoria,

27th February, 1930.

Sir,

Mr. C. E. Legat, the Chief Conservator of Forests, has submitted to me the manuscript of a paper by Dr. John F. V. Phillips, formerly of the Forest Department and entitled "Forest Succession and Ecology in the Knysna Region." In doing so Mr. Legat has suggested that since the work is mainly of a botanical character I might consider it for publication as a Memoir of the Botanical Survey of South Africa, and he has indicated that if this were considered possible he would be prepared to contribute towards the cost of printing the same.

The work is a masterpiece of ecological and forest research in South Africa, and should serve as a model for future research which young South Africans might well follow. The treatise is of such an important, useful and highly instructive nature that it should most certainly be printed by the Department which has enabled Dr. Phillips to carry out this work.

I therefore beg to recommend that you authorize the publication of this work as Memoir No. 114 of the Botanical Survey of South Africa.

I have the honour to be, Sir,

Your obedient servant,

I. B. POLE EVANS,

*Director, Botanical Survey of South Africa.*

The Secretary for Agriculture,  
Pretoria.

# "FOREST-SUCCESSION AND ECOLOGY IN THE KNYSNA REGION."

## INTRODUCTION.

APART from the data obtained by Bews in Natal, very little is known concerning the ecology of the forests of South Africa.

In view of the fact that the country has been inhabited by the European for a comparatively short period and possesses limited indigenous forests (less than 0.3 per cent. of the total area of the Union of South Africa is forest-clad), this lack of knowledge is to be expected.

The present preliminary paper is one of the results yielded by a systematic study of the ecology and silviculture of the forests of the Knysna Region since October, 1922—under the direction of the Chief Conservator of Forests for the Union of South Africa. The principal objects stimulating the study are as follows:—

- (1) The obtaining of data relating to the *setting, nature, and development* of the Forests.
- (2) The working out in detail of the life-histories of the more important species of trees and shrubs of the Forest-flora.
- (3) The application of all relevant information obtained, to practical silvicultural problems requiring solution.

*The present paper is confined in its objects to a preliminary description of the general setting, nature, and development of the Forests of the Knysna Region.*

From the outset the concept that the true foundation of a study with such widely-divergent aims must be quantitative data yielded by definite experimentation, supported by systematic observation, has been held by the writer. By observational (inference and sequence) studies, the quadrat-method, and instrumentation where necessary, the successional features and habitat factor have been elucidated to some extent. Intensive experiments carried out under *controlled* and under purely *natural* conditions alike, have led far toward a better understanding of the life-histories of the principal species; extensive field experiments checked wherever possible by smaller intensive experiments, have been productive of the most valuable results. More recently the promising method of Phytometry has been employed in comparative studies of forest-habitats, with encouraging results.

The writer is desirous of acknowledging the long-continued assistance, through the media of numerous letters and valuable books, of Dr. Frederic Clements of the United States. Thanks are due to the following scientific workers for their invaluable advice and assistance from time to time:—

Professors Adamson, Bews, Schönland, W. Wright-Smith, and Doctors Doidge, Pole-Evans, and W. G. Smith.

Opportunity is likewise taken of expressing appreciation of the kindness shown at all times by the Chief Conservator of Forests, C. E. Legat, Esq., the Chief Research Officer, C. C. Robertson, Esq., the Research Officers of the Forest Department Head Office, Pretoria, the Conservator of Forests, Knysna, Richard Burton, Esq., and by the several District Forest Officers (Messrs. D. R. MacArthur and F. S. Laughton more particularly) of the Midland Forest Conservancy.

Throughout the period of study, able assistance with the reading of instruments and with clerical work has been rendered by the writer's father, J. R. Phillips, Esq.

JOHN PHILLIPS,  
FOREST RESEARCH STATION,  
DEEPWALLS, KNYSNA, SOUTH AFRICA,  
22nd October, 1926.

## AUTHOR'S NOTE.

SINCE the foregoing was written I have taken up research in East Africa, hence, so far as my own investigations within the Knysna region are concerned, this is likely to be the only comprehensive monograph.

Toward the end of my service at Knysna, and more especially after coming into contact with the great fauna of East Africa, I became a convert to the concept that neither plant nor animal communities exist as *separate* entities, but that in Nature there is no community other than the *biotic*: wherein plants and animals behave as interdependent, coacting members of an integrated social organism. Unfortunately this concept was not developed to more than an insignificant degree in the manuscript of the present work, and to attempt to develop it now would entail a recasting of several chapters. The point is mentioned for the sole reason that the adoption of this concept is held to be a step nearer a better understanding of the fascinating and highly complex interrelations existing between plants and animals in the Knysna Forests.\*

Since the completion of the monograph it has been possible to publish a fuller account of the important subject of *forest types* in the Knysna region [Phillips, 1928 : (6)], as well as a comprehensive summary of the principal *indicator communities*. [Phillips, 1928 : (5).]

Papers published by myself since 1926 are listed in an *addendum* to the Bibliography.

It is desired to express my earnest appreciation of the very practical aid given by Dr. I. B. Pole Evans, C.M.G., in the matter of the publication of this work by the Botanical Survey of the Union of South Africa. I have happy memories of Dr. Pole Evan's continued interest in my investigations.

To Dr. E. P. Phillips are due my thanks for his excellent service in seeing the work through the press. My wife has rendered invaluable service in proof reading.

That this all too imperfect an account of the ecology of South Africa's most extensive, and certainly most beautiful forest region, may serve to commemorate the name of E. B. Dwyer, Esq.—one-time Conservator of Forests at Kingwilliamstown—who inspired in the writer his first love for the forests of his country is my very sincere wish.

JOHN PHILLIPS,

KONDOA IRANGI,

TANGANYIKA TERRITORY,

1930.

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\* See Phillips, 1930 (1) for some details.



# "FOREST-SUCCESSION AND ECOLOGY IN THE KNYSNA REGION."

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# Chapter I.

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**GEOLOGY, TOPOGRAPHY, SOILS.**





## GEOLOGY, TOPOGRAPHY, SOILS.

Situated between 22 deg. 20 min. and 24 deg. 40 min. E. Long., slightly north and south of the 34th parallel, S. lat., bounded on the south by the Indian Ocean, barred from the interior northward by the Outeniqua and Zitzikamma Mountains, is the 5-30-mile wide plateaued coast belt of the districts of George, Knysna, Uniondale, and Humansdorp. Within this region lie maechia, forest, and scrub—the maechia being usually taller and more luxuriant than that at the Cape Peninsula, the forests, the largest in South Africa, the scrub, on the whole, less xerophytic than that of the Karroo and the Eastern Province.

Originating in far-off Bushmanland, continuing southward and successively known as the Bokkeveld, Cedarberg, Langberg, Outeniqua, and Zitzikamma Ranges, the mountain barrier north of this territory, since Jurassic times at least, has exerted a potent influence on the physiography, climate, and vegetation of the narrow strip of land it guards. The Outeniqua-Zitzikamma-Karedouw Ranges—the local names given the barrier as it passes from west to east—rise, at times from buttressing foothills of considerable size, at times abruptly from hills scarcely higher than the mean level of the plateau on which they seem to rest, to elevations of 4,000-5,000 feet, the Everest of the region being Peak Formosa (or Krakeel River), of 5,497 feet. From the foothills, smaller or greater, rise the vast lateral spurs—at times 500-2,000 feet above the deep, tortuous kloofs separating them—that form the body of the ranges, serving as massive foundations for the oft-times precipitous, krantz-faced, rocky spine—itself 500-1,000 feet high—at the summit. On the higher portions of the barrier-range the angles of declination are frequently 70-90 degrees. While these diminish considerably as the lower levels are reached, it is not uncommon to find extremely high angles of slope even at elevations of 2,000 to 3,000 feet.

Attending to the coast-belt itself, this is found to be made up of a series of plateaux, commencing 600 feet or more beneath the waters of the Indian Ocean, and rising gradually as it proceeds inland. Of these plateaux three only, demand description.

Lying submerged about 600 feet, and extending a number of miles out to sea, is the first plateau, the edge of which is famed as the *Agulhas Bank*. From the shoreward margin of this, the second plateau rises, for the most part abruptly, as a cliff-faced terrace, from out the boiling surf; it assumes a height of from 500-700 feet near the sea. (Between the Kaaيمان's River and Gecceke Point, west of Knysna, the ever-blowing sea breezes have been responsible for the building up, during recent times, of a vast bank of dune-sand, several hundred feet in height. This wind-deposited barrier separates the sea from the George and Knysna lakes, which lie between the 700 foot plateau and the coast, in this particular region.) Extending 3-10 miles inland, intersected and re-intersected by deeply eroded river, stream, and kloof beds, this plateau varies from 500-1,000 feet elevation. This is known as the *Uplands Plateau*. It gradually assists in building up the foundations of the next, or *De Vlucht* plateau, to which it finally gives place on the north.

The *De Vlucht Plateau*, lying at 1,200-1,800 feet, in turn proceeds inland until it reaches the foothills or relatively low-lying lateral spurs of the barrier-range. Everywhere it shows deeply trenched, highly graded, narrow and tortuous valleys separated by row upon row of rounded-off ridges, all cut down to a comparatively common level. East of the Keurbooms River this plateau gradually disappears.

The major streams proceeding from west to east are the Brak, Zwart, Knysna, Keurbooms, Groot, and Storms Rivers. These have worn sinuous, steep, narrow gorges in the two plateaux, in instances several hundreds of feet deep: evidences of a young topography.

Occasionally, wider valleys with far less steeply inclined slopes are found where the softer Bokkeveld and Enon Beds have been extensively eroded by the rivers. The rivers are shallow except at their estuaries, are torrential, and quite unfitted for navigation except of the very meanest kind, and that for a few miles only.

The estuaries have been cut through the edge of the 700 feet plateau, and in instances these are flanked by dunes of aeolian drift. There are indications of drowning of the river mouths through *subsidence*, this process being complimentary, but subordinate, to that of *elevation* supposed to have been at work during the ages of geological time.

The occurrence of the barrier and of the three plateaux, and the indications of subsidence, are of more than passing interest, as reference to Schwarz's report on the geology of the region shows (Schwarz : 1905 ; 80-83). Briefly, Schwarz considers it probable that a see-saw motion in the rising and sinking of the land took place, the former being the more considerable. He concludes that the plateaux are *plains of marine denudation*, the points in favour of this being the occurrence of clays, sands, and gravels on the plateaux, and that the extreme narrowness of the plateaux would prevent the exceedingly short, highly graded rivers from acting upon the land so as to form *peneplains* or *base-levels of river erosion*. Rogers and Du Toit (1909 : 383), however, dissent from Schwarz concerning this explanation of origin of these and of similar plateaux covered with gravels, both within and exterior to the Cedarberg-Langbergen Ranges. Indeed, they take the very view Schwarz rejects : *The plateaux are plains of river erosion, and their dissection is due to their being subsequently elevated and to the down-sawing action of the rivers*. They state that the concept of plains of marine denudation is inadequate to explain why marine shells should be absent from so large an area in the Knysna region westwards, while in the raised beaches in the Uitenhage district they should be so well preserved.

After very careful observations throughout the greater portion of the region, the present writer inclines to the view that *the plateaux have truly been formed through lateral planation by rivers and streams, considerably assisted by gradual elevation of the land-surfaces above the sea*. It is evident that at one time the height of the land above the sea was considerably less than it now is. The rivers flowing from the mountain-barrier seaward, at first would probably erode the plateaux in a general north to south direction ; at the outset they probably were fairly straight, but later would develop bends, numerous tributaries, and innumerable subtributaries. The chief gradational forces must have been directed in downward directions and not in lateral ones—until such time as either more durable strata were met, or until the general level of the base of the river system had been eroded to a depth not much above the level of the sea, or possibly until a phase of subsidence of the coastal plateau came into action. The second and third possible causes of the down-acting processes being held in check are the more likely. Assuming that one or other of these two did take place, it is evident that the gradient of the rivers would become decreased to an appreciable extent, the result being the increased development of the tributaries and subtributaries.

Now this development of these smaller water courses would set up lateral erosion, the intervening smaller plains or ridges being gradually planed away until the main plateaux were worn down to approximately general levels—*base-levels of river erosion*. A further elevation of the land would re-initiate the cycle of gradation by increasing the gradients of the main waterways relative

to the ocean. Thus the complementary processes of *elevation* and *subsidence*, and of *erosion* and *deposi*t probably have been the grand factors in the formation and sculpturing of the high-level plateaux.

Judging from the *ligniferous sands of the Knysna Series*—described briefly in a later paragraph—lying in large basins in the *De Vlucht Plateau* and in smaller ones in the *Uplands Plateau*, the plateaux have been above the sea since Tertiary Times (late).

The barrier-range north of the plateaux was probably formed during the long interval between the late Palaeozoic and the early Cretaceous—perhaps during the Jurassic. Great thrusting from the south probably was responsible for these foldings; denudation must have been at its maximum for a lengthy period following the foldings, for it is likely that the mountains rose to greater heights then, than they do to-day. The material probably went to form the Uitenhage beds of the region, most of which have now, of course, disappeared.

The formations occurring in the region are as follows :—\*

System.	Series.	Characteristics and Localities.
Pre-Cape..... (Archaic)	Granite bosses.....	There are two well-defined granitic bosses in the George District, the larger is about 30 miles long and 4–10 miles wide, the smaller belug about 10 miles long and 2–4 miles wide. They consist of a white muscovite granite, with occasional black biotite; they are not solid, but much crushed, creviced, and injected. They are clad in dense Macchia and Forest, and with their termination in the George District, there is an accompanying change in the strike of the barrier range, from east to slightly south of east. They are the last granitic bosses in the south of the African Continent.
Do.....	Malmesbury.....	The larger granitic boss near George touches on the north, east, and south-east, the slates and quartzites of the Malmesbury Series, which bounds the smaller granitic boss on the west, south-west, and north. The slates have been penetrated by masses of granite, have been much sheared, and show in instances profuse development of mica; sheared phyllites and carbonaceous slates fairly rich in plumbago also occur. The extent of the series is less than that of the granite
Cape..... (Devonian)	Table Mountain Sandstone	Quartzites, sandstones, shales, forming the whole of the barrier-range and most of the plateaux; non-marine; probably a fluvialite deposit from shallow water on a slowly sinking area.
Do.....	Bokkeveld Beds.....	Quartzites, sandstones, shales, slates. These are infinitely softer beds than those of the Table Mountain sandstone, on which they lie conformably. They occur to-day as small inliers in synclinal valleys, the remnants of much larger portions let down among the harder beds of the Table Mountain sandstone by the great folding movements. They contain marine fossils—Orthoceras, Bellerophon, Spirifer, and others. The beds are far better represented than shown by Schwarz (1905), there being numerous small inliers in the Forests.
Cretaceous.....	Uitenhage (Enon Beds)	Conglomerates, sandstones, shales, with non-marine fossils; no definitely known plant remains have been found; pockets of poorly preserved lignite occur at the Bitou River. The nearby beds of Pisang River show more sand and clay, and finer conglomerates than those at Brenton (Knysna estuary) and at Bitou River. The mixture of pebbles, boulders, and fine material at Phantom Pass, may have occurred as the result of a mud-rush in Jurassic-Cretaceous Times.

\* Vide maps of the region, for distribution of formations, partly original, mainly adapted from Schwarz (1905).

System.	Series.	Characteristics and Localities.
Cretaceous.....	Sunday River Beds...	Fossiliferous marine clays and limestones occur at Brenton in Knysna Estuary. Fossils found are <i>Trigonia</i> , <i>Nautilus</i> , and <i>Ostrea</i> . These beds are of very small extent.
Recent and Pleistocene	Knysna Series.....	In the main forest near Knysna, at 1,000 to 1,300 feet elevation, there are deep hollows in the Table Mountain sandstone filled with sandy deposits bearing layers of semi-lignified and lignified coniferous stems, 6-10 inches in diameter and from several to over 20 feet in length; in addition there is true lignitic material in which the woody nature no longer appears. In all, the beds are over 200 feet deep, the lignified materials being in layers usually about 10 feet thick. They have been treneched to their base by local streams, showing that they must be of fair age. As the soft deposits would have been readily eroded on emergence, it seems clear they could not have been in position when last the plateau on which they rest was played upon by the ocean; moreover, there are no signs of a marine history. Probably they were laid down in fresh water when the land on which they lie was lower with reference to the ocean than it now is. Rogers (1909) has outlined the nature of the deposits; the present writer has worked on the lignified stems and found them to be of the same species throughout; a species of <i>Widdringtonia</i> . No other plant remains were found by the writer, but Rogers (loc. cit.) records some leaves which have been identified by J. F. Phillips, 1927 (3) as those of <i>Podocarpus elongata</i> L'Herit., <i>Gonioma Kamassi</i> . E. Mey., and possibly <i>Curtisia faginea</i> Ait.
Recent and Pleistocene	Alluvium.....	Estuarine deposits below the surfaces of the various rivers, especially the Knysna, Noetzie, Bitou-Kourbooms rivers; also occur along the banks of these estuaries. The deposits are greenish sands and silts bearing marine shells belonging to extant species of the adjacent ocean.
Recent and Pleistocene	Ironstone-gravel, peat-ironstone, pseudo-lateritic nodules, or "ouklip"	Very abundantly developed at depths of 3 to 36 inches below the soil surface, especially in depressions. The deposits sometimes occur as sand-and-clay-free Limonite (hydrated sesquioxide of Iron), but more often as a sandy-ironstone not without superficial resemblance to a larva flow. The formation is brought about by the concentration of the Iron oxide near the surface of the subsoil, the poor drainage being responsible for its deposition from the watery solution of Iron, in excess of the original constituents of disintegration.
Recent and Pleistocene	Aolian Drift.....	The sand is the result of long-continued breaking-up of shells and stones by the pounding action of the surf. The breakers toss up the sand, which is then borne inland by the sea winds.  There are extensive dunes along the coast between Kaaimans River and Gerecke Point at Buffalo Bay, on Knysna Western Head at Groot River mouth, and along the Zitzikamma coast in various localities. They are usually <i>Maechia</i> , Scrub, or Bush clad several hundred yards from the sea. Some of the deposits between the Knysna Eastern Head and Harkerville, shown as Drift by Schwarz (1905; map attached thereto), to the writer appear to be portions of the Knysna Series.
Recent and Pleistocene	Raised Beaches.....	Some well-preserved raised beaches occur near the river estuaries, the shells being those of extant molluscs.

## INFLUENCE OF GEOLOGICAL FORMATION ON VEGETATION.

There seems to be a tendency on the part of ecologists to underrate the importance of the rôle played by geological formations in the development and moulding of vegetation. At the Knysna, however, some interesting features are revealed by a study of the vegetation as influenced by the geological formation on which it occurs:—

(1) Forest of climax nature occurs on all the beds above mentioned, excepting the Enon and Sunday River Beds, alluvium, and raised beaches, but the *type* of forest is influenced profoundly by the nature of the underlying rock when this is at no great distance below the level of the root systems of the trees. Macchia likewise shows variation according to nature of the substratum, but to a lesser degree than forest.

2. Apart from differences due to aspects, elevation, and purely local drainage and seepage, it is usually found that forest and macchia growing on soil overlying Table Mountain sandstone to less than about a dozen feet, are of *moister type*, of greater vigour, and better stocked with regeneration, than are those forest and macchia communities on Bokkeveld Beds. The Bokkeveld Forests have a dry appearance as regards the lower layers of woody shrubs and herbs; ferns are not nearly as plentiful nor as luxuriant as they are in forest on Table Mountain sandstone. The soil itself has a drier appearance than that of the latter type of forest, and on examination in the laboratory registers a lower average holard. The differences between the forests are attributable to the relatively rapid drainage of moisture through the porous Bokkeveld as compared with that through the Table Mountain sandstone, thus producing reduced holard especially in times of local drought. The slight chemical differences between the soils derived from the two formations are not considered sufficiently important to produce *type* differences; indeed, if anything, one would look for a better type of forest on the Bokkeveld-derived soils in virtue of their slightly richer supplies of salts. The pH values are usually higher, that is the soils are less acid, in the Bokkeveld Forests; at times they are even slightly alkaline (*vide* p. 30 for table of pH values).

3. On the Table Mountain sandstone different *types* of forest may occur: a very-well drained, dry to medium-moist *type*, and a decidedly badly drained, over-moist *type*. The dip of the beds has been found to be responsible for this *type* difference; horizontal, or nearly horizontal beds underlying the latter *type*, steeply dipping beds the former.

4. It has not been found possible to observe marked differences between the forests growing on Table Mountain sandstone and on the Malmesbury Beds. The fact that much of the vegetation on the latter formation has been considerably disturbed by exploitation, fire, and grazing for the past century, may be in part responsible for this, but even those few portions of undisturbed vegetation that still occur on the Malmesbury, show no marked differences from vegetation growing on Table Mountain sandstone.

5. As the Uitenhage Series in this region occurs practically at sea-level, or within a mile or two of the ocean, it is difficult to imagine what the influence of the formation itself, upon vegetation, would have been. Judging from the nature of the Alexandria Forests lying between Port Elizabeth and Port Alfred, and in parts five to ten miles from the ocean, the *type* would be intermediate in moisture relations—slightly moister than Bokkeveld Forests, slightly drier than Table Mountain sandstone. There are several isolated forest patches lying at 300–400 feet elevation, and fairly well sheltered from the sea breezes, near Knysna village; these are on the Uitenhage Beds.

Although these for over a century have been much interfered with, it is clear from observations made in them, that provided climatic factors are much the same, forest on Uitenhage Beds is of lower height-growth than forest on the formations already discussed, and in addition, exhibits a greater development of thorny species and lianes. These features are also shown at Alexandria.

6. The occurrence of pseudo-lateritic nodules at depths of from twelve to twenty-four inches results in the production of a drier, shorter *type* of forest on Table Mountain sandstone. In times of drought, the more moisture-requiring species show signs of discomfort. Macchia on such deposits (at times three to six inches only, below the soil surface) shows a decreased luxuriance. In moist weather the macchia soils become water-logged, and show high acidity (pH 4 to pH 4.5). The presence of high-lying, thick laterite has a profound influence on the class of tree plantation that can be grown on the site—poor, stunted trees usually being the product of such localities.

7. Aeolian Drift, as in the instance of the Uitenhage Beds, usually occurs so near the sea that its direct action on vegetation often cannot be separated from that of climatic factors. At Harkerville, however, at an elevation of from 600 to 800 feet, and at distances of from one to three miles from the sea, extensive development of old Aeolian Drift does occur—overlying the Table Mountain sandstone to a great depth. Here the influences of proximity to the sea can be slight. The forests are of excellent nature, but, on the whole, are slightly shorter than those on Table Mountain sandstone (excepting the *type* on shallow pseudo-laterite). The forests are also somewhat drier, and show greater development of thorny species.

8. The various species of the forest and macchia show preference for neither one formation nor another, occurring on all. Naturally, differences in density and luxuriance do exist, in accordance with what has been stated in the foregoing accounts.

Summing up, it is possible to state that while species may be found on all formations, while forest and macchia may occur on almost all, there are slight differences produced in the form and structure of these communities, as the result of geological formation, provided the soil does not cover the strata to too great a depth.

The subject of influence of geological formation and derivation on the nature of the soil is discussed in the next section.

#### SOILS.

##### *Past Work.*

The physical, chemical, and biological nature of the soils of the region has received very little study. The reason for the small amount of attention paid to these subjects is that the country is for the most part a non-agricultural one, and until very recently, was not much utilized for the planting of exotic tree plantations. A careful investigation of the various soil factors and soil classes on those areas now being planted so extensively with exotic trees, is urgently required, if the best results are to be obtained.

Such work as has been done, is described, together with the writer's own observations, in the paragraphs to follow:—

##### *Influence of Geological Formation and Derivation on Nature of the Soil.*

At the Knysna, as everywhere else, soils lying *in situ* on their mother-rocks naturally are much more directly influenced by the chemical and physical properties of their parents, than are those soils that have been removed from their original sites and have been re-deposited elsewhere, after greater or less mixing with soils of other formations, or of similar formations in other localities. While undue emphasis has been laid upon the importance of geological origin

by some students of soils, it is nevertheless perfectly true that in particular instances very definite differences are reflected in soils of different geological origin, differences that are strikingly borne out by the natural vegetation *types* on the soils concerned. Thus at the Knysna, the 700 feet and 1,200 to 1,800 feet plateaux are geologically young, much of the soil lies *in situ* on the parent rock, and has been fundamentally effected in nature by the latter. The reverse : that little difference is shown between soils of different origins, is also exemplified in parts of the region—the soils of the granitic bosses and of the Malmesbury Beds are physically, chemically, biologically as poor as are those of the adjacent Table Mountain sandstone, practically no differences being shown by the vegetation on the several formations.

Returning to the subject of the soils of the plateaux being influenced by the mother-rocks, we find that the Table Mountain sandstone yields a distinctly poor soil—fine-grained, close, cold clays near the mountains ; fine-grained clays richer in sand on the plateaux.

Chemically, they show poverty, the chief constituents, lime, potash, and phosphoric acid not reaching 0.1 per cent. of the weight of the fine earth, and very frequently being represented by such low figures as 0.02 per cent. lime, 0.01 per cent. potash, and 0.01 per cent. phosphoric acid. Juritz (1910 : 164), working with forty-six soils from the Table Mountain sandstone in various districts of the south-western region, gives the average percentage of the reserve plant food as lime 0.034 per cent., potash 0.031 per cent., phosphoric oxide 0.036 per cent.

The present writer has found the pH values, on the whole, to be low, ranging from pH 4 to pH 5.9 or 6.

The Bokkeveld Beds, occurring as inliers in synclinal valleys in the Table Mountain sandstone, show soils somewhat different from those of the latter formation with regard to physical and to chemical properties. Physically, the soils are much more porous, are better drained, and more friable. Chemically, they are much richer in lime, potash, and phosphoric oxide, containing as much as from 0.2 to 0.3 per cent. lime, 0.1 to 0.2 per cent. potash, and 0.1 to 0.15 per cent. phosphoric oxide. The pH values are high—pH 6.0 to pH 8 (*vide* page 30 for table of pH values).

Differences in vegetation *type* in communities on these and on Table Mountain sandstone soils have already been discussed.

Naturally, modifications are introduced by the advent of external factors ; thus the Table Mountain sandstone soils near the coast line are much improved by lime-containing aeolian sand, rendering the soils less compact and less acid.

Soils of the Uitenhage Series, too, are markedly different from those of the Precape rocks and the Table Mountain sandstone, but approach in chemical value those of the Bokkeveld Beds, being fairly well provided with lime, rather less so with potash, and slightly less so with phosphoric oxide. Their reaction is slightly less acid than that of the Bokkeveld. Physically, the soils are lighter, but more retentive of moisture than those of the latter beds. In places near the ocean they have been much altered through the incoming of aeolian drift, and in lower depressions, by the deposits of alluvium from the interior.

From the foregoing, it seems clear that the geological formation at the Knysna cannot be said to play a part entirely unimportant so far as nature of the soil is concerned. This is in part the reverse of the opinion of D. E. Hutchins (1893 : 128), who stated that the poverty of the "moorland soil" was independent of the geological formation, and was due to climatic conditions entirely. Without desiring to detract from the truth of his statement that the climatic factors do wield a powerful influence on soil nature within the region, it is suggested that a factor of such obvious importance as the geological origin should have received greater recognition.

*Influence of Climatic Factors on the Nature of the Soil.*

Hutchins (loc. cit.), as already mentioned, believed that the soils of the region were acid and unfertile owing to climatic factors. In this connection he considered the following conditions responsible for the poverty of the soils :—

- (1) The leaching out of plant foods by the frequent rains, as fast as they are formed from organic matter and rock minerals.
- (2) The absence of frost sufficiently severe to assist appreciably in the breaking down of the rocks.

Observations made by the present writer lead him to conclude that the leaching effects of the well-distributed and copious rainfall are without doubt far-reaching. Lysimetric measurements carried out at Deepwalls indicate that the upper layers, humus and soil proper to a depth of from 6 to 12 inches, yield 70-90 per cent. of their water content, in heavy rains, to the underlying soil and subsoil. This results in continuous leaching of salts from out these upper layers. The acidity gradients (*vide* p. 30 for table of pH values) so common in the soils of the region are to be accounted for not only by the greater amount of organic matter in the upper layers, but also by the removal of bases from these layers, and their deposition at lower ones. Actual loss of salts from the lower levels, too, takes place through lateral drainage, especially on steep slopes. The water of streams annually bears away some portion of the chemical foods washed from out the upper and lower soil layers. Organic matter as well as inorganic is removed to a considerable extent. Examination of the river water at almost any time of the year shows it to contain organic and inorganic acids: even when flowing strongly, such water shows pH values ranging from 5.7 to 6.5.

The sequence of results following the occurrence of a heavy annual rainfall (*vide* Tables XX and XXII for rainfall data) and a base-deficient country rock is interesting: soil and vegetation are influenced, while domesticated animals and man also are affected. Domesticated animals, to ensure their successful rearing, require artificial supplies of bases, while the acid water used for drinking purposes by the indigent woodcutter (European) population seriously decays the teeth at an early age, and thus lowers the general vitality of persons of all ages.

Reverting to the leaching effects of the heavy rainfall, a most important result of leaching and re-deposition is seen in the formation of the extensive pseudo-lateritic nodules, or "ouklip," already described (*vide* p. 16). These semi- or totally-impermeable pans exert an influence on vegetation in some respects comparable with those of "Ortstein" in North Germany and elsewhere in Europe, as described by Graebner (1901) and others. The effects of this formation on vegetation at the Knysna has already been mentioned (*vide* p. 18). It remains to add that macchia often remains climax or sub-climax on areas where the layers are shallow and thick; on such sites the formation of the deposits is still in active progress.

The slight influences of frost, too, are important both in natural and in worked soils. The clods of the plough "cake" hard on drying, as there is insufficient frost to break them down. So far as rock-decomposition is concerned, however, it is noteworthy that the roots of trees and macchia plants exert a strong influence in the direction of the making of new earth, and possibly compensate for the rarity of frost. Sandstone lying from 6 to 24 inches below the surface of the ground, in forests, in its upper portions is seen to be porous,



friable, and readily breakable, whereas strata at slightly lower levels are absolutely impermeable. This gradual alteration of the rock must produce much new material for soil-formation.\*.

### *The Influence of Fire upon the Nature of the Soil.*

Hutchins (1893 : 128) draws attention to the evil influence on the soil of fires in the mallee, these fires sending seawards such plant-food as has been formed by the vegetation at the soil surface.

C. B. McNaughton, Conservator of Forests in this region from 1897 to 1908, in various Forest Department reports emphasizes the detrimental results following the continued burning of mallee soils. Bews (1918 : 148) has touched upon the subject of soil-erosion in South Africa, resulting from firing of natural grassland, while E. P. Phillips (1920 : i and ii) has carried out veld-burning experiments in grassland at Pretoria. The emphasis in Phillips's work has been more in the successional aspects involved, but the following conclusions were arrived at with respect to purely edaphic factors :—

- (1) The temperature of soil covered by vegetation has a more even range than that of soil denuded ; diurnal temperatures were much higher on the denuded than on the vegetation-clad sites.
- (2) Denuded soil takes up more water after rain than does vegetation-clad, but evaporation is so severe that the water-content soon drops. Vegetation-clad soil shows less fluctuation in this respect.

Thomas Eden (1924) has contributed a thoughtful paper to the subject of edaphic factors accompanying the succession after burning. He carried out experiments on Harpenden Common, Hertfordshire, England, and so important is the bearing of some of his results that a discussion of certain of these at this juncture is justifiable.

The lime-requirement (Hutchinson and McLennan, 1915) is greater on burnt than on unburnt ground, and this difference is the more marked in the uppermost soil layers. The values given by Eden are :—

Nature.	Depth in Inches.		
	0-1.	1-4.	3-7.
Burnt soil .....	0.50	0.37	0.29
Unburnt.....	0.37	0.33	0.28

These differences decrease as the succession proceeds toward the climax. Several hypothetical explanations for the phenomenon are advanced, but Eden favours the view that burning increases the humic bodies, and thus increases the lime requirement. Increased humification occurs on burnt soil, and this difference between burnt and unburnt soils decreases as the succession proceeds.

The potash content is not increased by release of this salt from the ash of the vegetation. Destruction of vegetation reduces the moisture content of the soil in the first inch, but the lower levels are moister in burnt ground than in unburnt.

The determining factor, he concludes, is humic content, working, perhaps, through soil-acidity.

\* *Vide* p. 206.

The subject has received a little attention from the writer, in connection with general succession studies. Soils in burnt macchia have been compared with those from macchia unburnt for five years, adjacent. The more important data so far obtained from experiments are :—

pH values for the upper 1 to 6 inches of soil (rich in humus) decrease after burning : that is, soil acidity increases, as shown in the table below :—

Nature.	Depth in inches.	
	0-1.	4-6.
Burnt soil.....	5.0	5.5
Unburnt.....	5.6	5.6

As the succession progresses, the differences decrease and eventually disappear.

The surface-soil temperatures, as well as those temperatures recorded at a depth of 6 inches below the surface, are considerably higher in burnt soil than on unburnt. Temperatures of 150° F. to 170° F. are of frequent occurrence at the surface during warm periods throughout the year ; the subsoil (2 to 4 feet according to locality) temperatures show little increase—3 to 5 degrees F. greater than those recorded for the same depth under vegetation ; the temperatures at 6 inches below the surface, however, in newly-burnt soils are usually 10-20 degrees higher than those for soils under macchia.

The holard of burnt, fully-exposed soils is lower in the upper 6 inches than that of similar macchia- or forest-covered soils adjacent, but often the difference is in the reverse direction, at greater depths. When the ash lies *in situ*, it and the dry debris assist the upper soil in conserving the water of the lower layers, they being mulch-like in their action.

During windy weather, considerable loss of ash is caused, the soil being swept clean ; drying winds smooth and harden the surface. If heavy rain follows such winds, the baked surface absorbs little moisture, the run-off is great, the water speedily finding its way to streams. Northern, north-western, and north-eastern slopes suffer more in these respects than do those of southern nature.

Useful animals, such as earthworms, are killed in the upper layers, and do not reappear in large numbers for some years.

Humus content is lowered by burning ; a severe fire destroys almost every trace of humus and semi-humified litter.

The whole subject is a fascinating as well as an important one in forestry and agricultural economics. Wholesale burning of soil is carried out year after year ; the effects of such practice should receive careful scientific investigation, for the end results might prove detrimental to soil quality and productive capacity. In this connection see Phillips ; 1930 (2).

### *The Physical Properties of the Soils.*

The physical properties of the Knysna soils have received practically no study apart from the observations of McNaughton (in various Forest Department records) and the recent investigations of the present writer.

McNaughton's observations may be summarized thus :—

The depth of the soil naturally varies much—from a few inches to several feet. The subsoil usually is a clay, either heavy and compacted, or else loose and friable. Finely-divided sand occurs in some localities, while in others are

clay-slates, sandstone, and conglomerates. Patches of pea-ironstone, so common a feature of acid soils, are abundantly developed. From the timber-producing point of view, there is sufficient depth of soil and subsoil to carry the majority of timber species successfully.

The physical factors that have received attention from the writer are the *general physical composition* and the *moisture-contents*. A full discussion of these investigations here is not possible, by reason of space, and also because sufficient information on many important points is not yet available. A concise summary of the leading features so far noted alone is attempted.

#### *General Physical Composition.*

Following Hilgard (1912: 84), Phillips has arrived at the percentages of plastic clay in the soils by placing the limits of this material at and below such grain sizes as will remain in suspension in an 8-inch high solution of distilled water for 24 hours. For all practical ecological and forestry purposes it seems that sufficient accuracy is obtained by this method. According to this method of clay separation, the soils of the region may be classified as follows:—

Class of Soil.	Percentage of Clay.
Dune sands.....	Less than $\frac{1}{2}$ per cent.
Littoral Bush sands.....	3-5 per cent.
Sandy loams.....	10-15 per cent.
Clay loams.....	15-25 per cent.
Moderately heavy clay soils.....	25-40 per cent.
Heavy clay soils.....	40-50 per cent.

*The heavy clay and the moderately heavy clay soils* are best represented by the soils at fairly high altitudes, near the mountain slopes, and very often on these. These soils usually bear macechia, either as the elimax or the subelimax vegetation. Examples occur on the plateaux as well, where macechia or poor class moist type forest prevails. The soils are stiff, compact, heavy, cold, and show high holard; they are abundantly provided with raw acid humus to depths of from 2-6 inches, and on the less steep sites overlies sheet rock or laterite at depths of from two to many feet. They exhibit high maximum water-retaining capacity (*vide* Hardy, 1923) and high eehard (Clements, 1905).

*The clay loams* are representative of much of the soil of the plateaux; these soils overlie heavy clay or laterite, or sheet rock; they are less heavy, are warmer, and better drained than those of the preceding class.

They support taller macechia and the bulk of the high forest, and their humus contents are accordingly high.

*The sandy loams* are to be found on portions of the "*Uplands*" and "*De Vlugt*" plateaux, but are better represented on the first-named; they owe their origin to the presence of the sandy beds of the Knysna Series and to aeolian drift; some soils of the Enon Beds may be grouped here, while much of the best alluvium may also be included. These are lighter, warmer, more porous, and better suited to agricultural purposes than the soils of the clay loams class. In nature they bear high forest and macechia.

As would be expected, notable exceptions to the general zonation of the soil types are to be found, e.g., excellent, porous, deep soils occur far inland, along the valleys of Bokkeveld Beds.

*Littoral bush sands* occur near the seashore wherever the precipitous cliff-edge of the "*Uplands*" plateau has been broken away by erosion or earth movements; the sands are derived from Table Mountain Sandstone covered to scores of feet in aeolian drift sand. The sand has become compacted with

time, and has been appreciably improved by the addition of much inorganic and some organic matter from leaf-and-branch-fall, over many centuries; the humus content is from 3 to 6 per cent. (loss-on-ignition method)—considerably lower than that of the foregoing classes.

Such sands support subclimax or seral littoral scrub or littoral bush, and, in the more sheltered localities, littoral-type high forest. When worked, they provide fair agricultural lands, but on account of their sandy nature are apt to be blown in heavy winds.

The *dune sands*, resulting from the disintegration and pounding down of shells and rock by the breakers, are identical with those of similar origin in other regions of the world, except that they are somewhat poor in lime. They bear the pioneer stages of the Psammosere described on a later page (Chapter 4). In localities (Buffalo Bay and Knysna Western Head) they are encroaching on the soils inland; at Buffalo Bay the Forest Department is taking active steps to stem the advance.

Table I.

REPRESENTATIVE SOIL CORES FOR EACH SOIL CLASS, TAKEN BY MEANS OF GEOTOMES.

Depth * in Inches.	Heavy Clays. (1)	Moderately Heavy Clays. (2)	Clay Loams. (3)	Sandy Loams. (4)	Littoral Bush Sands. (5)
2-6	Raw, acid humus.	Humus acid, but less so than in (1)	Humus acid.	Medium - acid humus.	Dry, slightly humus, very acid
6-18	Moist, black, heavy clay loam; very stiff.	Moist, black, or grey, heavy clay loam; openier than in (1)	Damp, grey clay loam; moderately porous and much lighter than (2) for working pur- poses.	Slightly damp, pale-brown to yellowish, porous sandy loam, readily worked.	Very pale, very light sand with slight admix- ture of sandy loam. Usually too light for working purposes.
18-48	Heavy red or yellow clay	Red or yellow clay, slightly less stiff than that of (1).	Coarse - grained clay, more permeable than that of (2).	Clay loam merg- ing into coarse-grained clay.	Sandy, decreas- ing in humus and loam contents.
—	Sheet rock of impermeable nature.	Sheet rock of impermeable nature.	Sheet rock of impermeable nature.	Semi - porous sheet rock.	Hard and im- permeable sheet rock.

\* Depth below the surface of the soil. Examples are from typical cores for each soil class; modifications are introduced through occurrence of rock nearer the surface, or through differences in angle of dip of the rock, or through occurrence of lateritic deposits immediately below the surface.

#### Moisture Relations.

With a well-distributed, fairly heavy rainfall, and a humus-rich soil well covered with vegetation, it is not surprising to find the moisture content of the soils abundant. Drought periods, which are rare, very seldom succeed in reducing the holdard of average soils to a point equivalent to or below the echard. Determinations of the holdard at intervals of from two to seven days, at various stations in the forest, have been made since 1922. Determinations have also been made in macchia soils from time to time. A summary of the mean holdard values for several of the stations follows:—

## REPRESENTATIVE HOLAD VALUES FOR SEVERAL STATIONS.

Station.	Description of the Localities.	Soil Nature.	Holad: Mean % on dwt. at 6-9 inches.	Holad: Absolute Maximum.	Holad: Absolute Maximum.	Cores Taken.
NOTE.—Stations Nos. 1, 2, 3, 4 are on the same hill, and at the same elevation (1,725 feet). Nos. 1 and 2 are on the northern aspect, 3 and 4 on the southern.						
1	Exploited Forest site, with vegetation entirely removed from soil; aspect north, slope 12 degrees; experiences severe insolation throughout the year; surface-soil temperatures and 6-inch-below-surface temperatures are given in Table VIII as well as temperatures 9 inches above the surface	Humus 2-3 inches; a grey clay loam over clay	33.0	54.32	15.48	At 6 p.m., twice per week for one year, 1923-24.
2	Under Forest canopy (70 feet), 20 yards from Station No. 1; high Forest of <i>Podocarpus Thunbergii-Olea laurifolia</i> , with abundant <i>Trichodadus crinitus</i> forming a 12-foot layer-society. Temperatures below and on soil surface, and above surface are given in Table VIII	Humus 2-3 inches; a grey clay loam over clay	40.0	84.50	23.73	At 6 p.m., twice per week for one year, 1923-24.
3	Exploited Forest site, with vegetation entirely removed from the ground; aspect south, slope 10 degrees; experiences severe insolation in summer months and during late August, September, April, and early May. Air temperatures in shade 5-10 degrees F. lower than those at Station No. 1; surface-soil temperatures 30-40 degrees F. lower; 6-inch-below-surface temperature 5-7 degrees F. lower	Humus 2-3 inches; a grey clay loam over clay	51.4	84.63	16.52	At 6 p.m., twice per week for one year, 1923-24.
4	Under Forest canopy (70 feet), 25 yards from Station No. 3; high Forest of same type as that at Station No. 2, but with frequent <i>Blechnum capense</i> and occasional relict <i>Hemelia capensis</i> and less <i>Trichodadus</i> . Air temperature in shade 2-3 degrees F. lower than at No. 2; surface-soil and 6-inch-below-surface temperatures are also several degrees lower than at the latter station	Humus 2-3 inches; a grey clay loam over clay	54.36	100.69	20.78	At 6 p.m., twice per week for one year, 1923-24.
5	Under the <i>Platylaphus-Unonia</i> associates. South aspect, 1,600 feet; dense layers of <i>Hemitelia capensis</i> . Temperature (air, in shade) 1-2 degrees F. lower than at Station No. 4. Light intensity, 1/800	Humus very abundant, and acid; clay loam, heavy, stiff, over heavy clay	172.85	222.0	118.0	At 6 p.m., twice per week for one year, 1923-24.
6	Under high Forest (70 feet); with dense layers of <i>Aspidium capense</i>	Mild humus, 3-4 inches; light clay loam over well-drained rubble	57.25	88.0	27.0	At 6 p.m., twice per week for one year, 1923-24.

The echard, or so-called "non-available water content of the soil," has been determined, employing the more important species of forest trees, in their seedling stages, and the principal types of forest soil. Without attempting to enter into a detailed account of the behaviour of the various species in the several soils, it will be as well to outline the principal indications so far obtained.

Briggs and Shantz (1912), in their pioneer, thorough, and most stimulating researches concerning the wilting coefficient for different species of plants in various soils, conclude that the differences exhibited by plants in respect of the wilting coefficient are much less than have been supposed, and are so insignificant as to be of little practical value so far as drought resistance is concerned.

Clements, Hedgcock, and others find that different species wilt at different echards in the same soil, while Bates and Zon (1922 : 79-80) certainly incline to this view, concluding that between species of trees adapted to fundamentally diverse habitats there may be, under certain conditions of wilting, radical differences in the wilting coefficients. The results obtained by Phillips at Deepwalls are in agreement with those who find that there are differences between certain species in one and the same soil. It is, for example, found that *Apodytes dimidiata*, *Ocotea bullata*, *Platylophus trifolius* seedlings will wilt in forest soil of clay loam nature at 17 to 20 per cent. echard (basis of dry-weight of ovened sample), whereas those of *Curtisia*, *Elaeodendron* spp., *Olea laurifolia*, do not wilt until the percentage has fallen to 10 to 15 per cent.; *Virgilia capensis* seedlings in the same soil may not wilt until the moisture is as low as 8 per cent.

The soils of heavy clay nature show echards considerably higher than those of the clay loam class, the values being between 30 and 40 per cent of the dry-weight of the ovened samples.

### *The Chemical Characteristics of the Soils.*

The chemical characteristics of the soils of the region have not been investigated intensively, but this much is clear: they are exceptionally poor in chemical foods. The earliest record of investigations into the chemistry of the soils is that of D. E. Hutchins (1890 : 99), in his Annual Report as Conservator of Forests. In his report he refers to chemical analyses, by the Agricultural Department of the Cape of Good Hope, of soil and subsoil specimens obtained from machia at Concordia. The method of analysis is not cited, but the findings were that the soil and subsoil alike were moderately rich in organic matter, but deficient in inorganic foods. Lime was present in exceedingly small amount, while phosphoric acid and potash, too, were very poorly represented.

No further work was done until 1900, when Juritz (1900) published the analyses of 19 soil samples taken from the Knysna district; of these only 1 was a forest soil, the rest being machia and agricultural soils.

The data for the 19 samples, together with the analyses of 29 samples from the George district, and 4 from that of Humansdorp, appeared in Juritz's "Study of the Agricultural soils of the Cape Colony," 1910.

None of the samples from the George and Humansdorp districts were from the forests. Without citing details, a summary of the results obtained by Juritz [employing the standard method of extraction with HCl (Juritz, 1910 : 13)] is of interest:—

- (1) The soils of the region round George are generally lacking in all the important mineral plant-food ingredients; while they are rich in nitrogenous matter, and contain fair proportions of potash in certain instances, their lime and phosphatic contents are exceedingly low. North of the Outeniqua range, in the valley of the Longkloof (Table

Mountain sandstone, with inliers of Bokkeveld), potash is more abundant, while lime is slightly better represented than elsewhere in the region.

- (2) The soils of the Knysna region proper are in most parts as poor as those of George, and indeed show a decrease in potash and phosphoric oxide contents; the lime, however, very slightly increases in parts. The nitrogenous content is high.
- (3) The alluvium soils round Plettenberg Bay are richer in lime than any other soils south of the mountains, while their phosphoric oxide and potash contents, too, are fair. Average values for the alluvium soils are given by Juritz (op. cit. 70) as nitrogenous matter, 0.242 per cent.; lime, 0.221 per cent.; potash, 0.067 per cent.; phosphoric oxide, 0.068 per cent.
- (4) The soils of the Storms River region (Humansdorp district) were equally poor with those of George and Knysna.
- (5) The single sample actually taken from the forest, at Millwood, Knysna District, showed much organic and nitrogenous matter, but a general deficiency in mineral foods. Juritz's figures (op. cit. 69) are as follows:—

Percentage of Field Sample Fine Earth.	Percentage of Soil Sifted through a 1 Millimetre Sieve.				Percentage of Soil Sifted through a 0.5 Millimetre Sieve.		
	H <sup>2</sup> O.	Organic Matter.	Chlorine.	N.	Lime.	Potash.	Phos. Oxide.
95.6	3.84	12.21	0.0813	0.413	0.032	0.028	0.056

Shantz and Marbut (1923) have seriously criticised the methods employed by Juritz in his investigation of soils of South Africa, as being of little utility and as yielding data that have no very definite meaning or value. While there can be no doubt that intensive work based on more recent and efficient methods is earnestly required in the Knysna and other regions of South Africa, it is equally manifest that Juritz has cleared the field of many obstacles that would surely have hindered workers of the future.

Since Juritz's work, the field has been untouched except for occasional Departmental analyses made by Stead. Stead's results are essentially as those obtained by Juritz, and need not be discussed here.

Chemical data collected by the present writer have been confined to determinations of the total soluble salts readily available to plants in the soil solution, and to determinations of pH values and organic matter content.

#### *Total Available Soluble Salts.*

The total soluble salts readily available to plants has been found to vary from 50 to 300 parts per million of the soil weight, the soils in forest usually being considerably richer than those of either climax or seral mallee. F. H. King (1905) has discussed in an exhaustive manner the subject under consideration. Bates and Zon (1922: 131) state that solutes varying in amount from 20 to 1,500 parts per million of the soil weight are ordinarily found in such extracts; hence the Knysna soils, even at their best (300 parts per million), appear to be of marked poverty.

*Hydrogen Ion Concentration of Soils of the Knysna Region.*

The sour nature of the soils of the region has long been known to practical men, and, indeed, received description by the earliest travellers.

Apart from the employment of the ordinary Litmus paper method, no investigation of the acidity factor was carried out until the writer commenced the determination of pH values for various soil-types in 1923-24. Bews and Aitken (1922), however, contributed the pioneer paper on the subject of the measurement of pH values in South African soils, in relation to plant distribution and other ecological problems. As their results have a direct bearing on work carried out by the writer in the Knysna area, they deserve summarizing here:—

Low veld and high veld soils in Natal were investigated colorimetrically. Of these the high veld showed the greater acidity (pH 4.5-5.0) the low veld being *miniacid* only (pH 6-7.0). Forest soils on the high veld, however, showed lower acidity than did those of open country (pH 5.4-5.7). Again, at Maritzburg, the northern slope of a hill showed pH 5.5, the southern 6.4; the northern slope bore grassy tree veld, the southern pioneer forest stages.

The most important feature indicated was the apparent decrease of acidity as the succession proceeded towards forest.

The writer has used the double-wedge comparator colorimetric method of Edgar T. Wherry (1924), and has endeavoured to compare the values obtained therewith with the qualitative indications yielded by the Comber (1920) and Truog (1920) methods. As Marloth (1924) has already pointed out, the Comber method does not yield results in keeping with the pH values obtained by colorimetric (or potentiometric) methods; on the other hand, Truog's method, when used with care, does supply qualitative data that are capable of being referred to quantitative data obtained by the colorimetric and electrical methods. The Truog method, on the suggestion of the writer, is being employed by several forest officers in the Knysna region, and with fairly consistent and satisfactory results.\*

The colorimetric methods, of course, are not entirely satisfactory. Bews (unpublished report to the Botanical Survey of South Africa, June, 1925) refers to this subject. So far as the writer's experience goes, the Wherry method in its most recent form, when used with care, and with properly regulated soil moisture ratios, gives results moderately consistent.

Numerous determinations of pH values have been carried out in various classes of soils and in various plant communities. A set of values giving a general impression of the acidity of the soils of the region is presented in *Table III*, page 30.

The following tentative conclusions with respect to acidity phenomena, have been drawn:—

- (1) Acidity is, on the whole, greater in macchia soils than in forest soils; exceptions are found when the heavy clay soils or heavy clay loams from deep, damp, shaded forest ravines in the possession *Platylophus trifolius*, are compared with the better class soils of the macchia.
- (2) With few exceptions there are well-defined "acidity gradients" in one and the same soil, the acidity decreasing as depth increases, to a limit of about 36 to 48 inches.
- (3) Acidity—with exceptions produced by local habitat and community factors—decreases as the sea coast is approached; the most acid conditions are found on the mountain summits, slopes, and foothills. Even far inland, however, acidity is less in Bokkeveld-derived soils, than it is in the surrounding soils of the Table Mountain sandstone.

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\* 1926.



- (4) Acidity is temporarily increased by the burning of macchia and forest (*vide* pages 14-15), but is decreased by slashing of macchia or exploitation of forest.
- (5) Earth-worm numbers per acre are related to degree of acidity, the higher the acidity, the lower the number of these organisms (*vide* Acanthodrilidae under "Soil Biota," page 33).
- (6) Judging from the extensive development of pseudo-lateritic nodules or "ouklip" of from 6-12 inches thickness—the production of ages of deposition of hydrated oxides of iron—acid conditions must have prevailed in the region for a very lengthy period, probably since shortly after the formation of the plateaux themselves.
- (7) Acidity is decreased appreciably by careful cultivation of the soil and by the addition of lime or other base-containing fertilizers.

Alkaline soils are represented by some neutral and circumneutral Bokkeveld and Enon soils, but alkalinity is rarely exhibited by the upper six inches, the organic matter tending to make the layer very slightly acid (pH 6.8 to 6.9). Soils showing alkalinity greater than pH 8 (specific alkalinity = 10, where pure distilled water = 1) are rarely met. The physical and chemical and productive properties of the alkaline soils are preferable to those of the acid soils of the rest of the region.

*Brak* soil is the other representative of alkaline soils in the region.

Table III.

No.	Position.	Formation.	Soil Characteristics.	Depth of Sample.	Vegetation.	Successional Condition.	Acidity Values.	
							pH.	Specific Acidity.
				Inches.				
1	Estuary of the Kourbooms River	Alluvium derived from Enon and Bokkeveld	Pale green, sandy loam, many feet deep	9-12	<i>Salicornia natalensis</i> - <i>Chenopodia diffusa</i>	Seral	8.0	0.10
2	Estuary of the Knysna River	Alluvium derived from Enon and Table Mountain sandstone	Pale green, sandy loam, many feet deep	9-12	<i>Salicornia natalensis</i> - <i>Chenopodia diffusa</i>	Seral	7.2	0.63
3	Uplands Plateau	Bokkeveld inlier in a synclinal valley; 600 feet elevation	Light sandy loam	9-12	Dry Forest; <i>Podocarpus Thunbergii</i> - <i>Olea laurifolia</i> type, with abundant <i>Trichocladus</i>	Climax	7.3	0.50
4	Noetzie River; Sea slopes of Uplands plateau, 200 yards from ocean	Old dune sand over Table Mountain sandstone; 20 feet elevation	Light littoral bushsand, with dry humus	9-12	Littoral Scrub; <i>Celastraceae</i> - <i>Sideroxylon</i> - <i>Rhus</i> , spp. are dominant	Seral	6.9	1.25
5	Noetzie River; Sea slopes of Uplands plateau, 400 yards from ocean	Old dune sand over Table Mountain sandstone; 30 feet elevation	Much as for 4, but firmer and with more organic matter	9-12	Littoral Bush; stunted <i>Podocarpus-Olea laurifolia</i> - <i>Celastraceae</i>	Seral or sub-climax	6.5	3.15
6	Noetzie River; Sea slopes of Uplands plateau, about half-mile from ocean	Old dune sand over Table Mountain sandstone; 30 feet elevation	Slightly heavier and richer in organic matter than for 5	9-12	Littoral Forest; <i>Podocarpus elongata</i> - <i>consociation</i> with <i>Aspidium</i> and <i>Knottia</i>	Climax	5.9	12.5
7	Uplands Plateau	Table Mountain sandstone; 800 feet elevation	Humus, 3 inches	1-2	Mixed High Forest; <i>Podocarpus-Olea-Ocotea</i> - <i>Apo-dytes</i>	Climax	5.0	63
	Uplands Plateau	Table Mountain sandstone; 800 feet elevation	Sandy loam	9-12	Mixed High Forest; <i>Podocarpus-Olea-Ocotea</i> - <i>Apo-dytes</i>	Climax	5.3	50
	Uplands Plateau	Table Mountain sandstone; 800 feet elevation	Clay	18-24	Mixed High Forest; <i>Podocarpus-Olea-Ocotea</i> - <i>Apo-dytes</i>	Climax	5.6	25

Table III. —(continued).

No.	Position.	Formation.	Soil Characteristics.	Depth of Sample.	Vegetation.	Successional Condition.	Acidity Values.	
							pH.	Specific Acidity.
				Inches.				
8	De Vlugt Plateau	Table Mountain sandstone ; 1,400 feet elevation	Clay loam over heavy clay ; rich in humus to 6 inches, laterite pan at 36 inches	9-12	Berzelia-Metasia-Cliffortia Erica ; height 8-10 feet	Seral (5-10 years old)	4.8	160
9	De Vlugt Plateau	Table Mountain sandstone ; 1,400 feet elevation	Clay loam over heavy clay ; rich in humus to 6 inches, laterite at 18 inches	9-12	Bobartia spp. dominant	Seral	4.5	315
10	De Vlugt Plateau	Table Mountain sandstone ; 1,400 feet elevation	Humus 2-4 inches	1-2	Mixed High Forest	Climax	5.0	100
	De Vlugt Plateau	Table Mountain sandstone ; 1,400 feet elevation	Clay loam	9-12	Mixed High Forest	Climax	5.1	80
	De Vlugt Plateau	Table Mountain sandstone ; 1,400 feet elevation	Clay	18-24	Mixed High Forest	Climax	5.4	40
11	De Vlugt Plateau, but in deep ravine	Table Mountain sandstone ; 700 feet elevation	Humus, 4-6 inches	1-2	Platylophus consociates, with dense Hemitelia	Subclimax	4.4	400
	De Vlugt Plateau, but in deep ravine	Table Mountain sandstone ; 700 feet elevation	Clay loam	9-12	Platylophus consociates with dense Hemitelia	Subclimax	4.9	125
	De Vlugt Plateau, but in deep ravine	Table Mountain sandstone ; 700 feet elevation	Heavy clay	33-36	Platylophus consociates with dense Hemitelia	Subclimax	5.3	50
12	Mountain Base	Table Mountain sandstone ; 2,000 feet elevation	Heavy, peaty clay over pan of laterite	9-12	Stunted Macchia ; Resti- aceae-Peneaceae	Climax	4.3	500
13	Near Mountain Base	Table Mountain sandstone ; 1,600 feet elevation	Clay loam over heavy clay	1-2	Macchia ; Burnt soil Unburnt soil	Climax	4.7 4.8	200 160

There are three types of brak soil present :—

- (1) The exceedingly brak sands and silts of the *Zwart Vlei* (George and Knysna lakes) *type*. This is brown to black, possesses little plant-food, and supports a scant vegetation of marsh forms. It is practically confined to the shores of the *Zwart Vlei* itself (vide Map No. 2).
- (2) The better class brak sands and silts of the rest of the larger George and Knysna lakes. This class has been improved by the addition of calcareous dune sand blown in from the shore. Vegetation is luxuriant.
- (3) The greenish brak sands of the Knysna, Bitou, and Groot River estuaries. This class is, in parts, hundreds of feet thick, and is the result of ages of accumulation of sediment in deep rock channels. This class bears a characteristic vegetation of halophilous plants, chief of which is *Salicornia natalensis*.

In all instances the brak is due to sodium chloride. In type (1) no calcareous matter is available for neutralizing or converting the salt. In type (2) calcium carbonate in the aeolian drift sand neutralizes the salt, while in type (3) the gypsum (calcium sulphate) of the Enon beds combines with common salt, forming the innocuous sodium sulphate ( $\text{Na}_2\text{SO}_4$ ).

#### *Organic Matter in the Soils.*

The soils, owing to the rich development of vegetation throughout the region, are exceptionally rich in organic matter; indeed in many instances there is a superabundance.

Little work has been done in connection with the important subject of determination of organic matter in the Kynsna soils; Juritz (op. cit. 1910) gives the percentages of organic matter in terms of percentage of soil sifted through a one millimetre sieve, the amounts being arrived at by the "loss-on-ignition" method.

The writer since 1922 has carried out a large number of determinations, employing the same method. While it is realized that the method has shortcomings,\* it is argued that the Grandeau (1877) method of determination of the "matiere noire," despite modifications by Hilgard (1906) and the work of Alway, Files, and Pinckney (1910), contains equal, if not greater, sources of error. Furthermore, as the nitrogenous matter in forest and macchia soils is known to be more than sufficient, there is little need to determine the amount of humified material proper, likely to serve as a nitrogen source; finally, the "loss-on-ignition" method gives the total organic matter present in the soil, and this has an obvious bearing on the water retentivity and aeration of soils. The carbonate content of the soils worked with is so extremely small, that practically no error is introduced by their breakdown on ignition.

The soils may be classified as follows, in terms of percentage of organic matter (in terms of oven dry weight of soil):—

- (1) Peaty soils of mountain summits, slopes, valleys, and certain foothills: 20-40 per cent.
- (2) Soils of moist high forest and of macchia, also alluvium soils: 12-20 per cent.
- (3) Soils of less moist high forest and macchia: 6-12 per cent.
- (4) Soils of littoral communities: 3-6 per cent.
- (5) Dune sands: less than 1 per cent.

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\* *Vide* Report, Sub-committee of the Agricultural Education Association: The Mechanical Analysis of Soils: *Jour. Agri. Sci.*, 16 (1): 128-129.

The subject of annual addition of leaf-litter to the soil is one of some importance, and concerning which there are few data apart from the observations of several of the older school of German foresters. The writer has collected the litter (leaves, twigs, flowers, fruits, bark, etc.) cast per annum by different associations of forest trees and shrubs, has air and oven-dried the material, and has then weighed it. The figures obtained are interesting :—

- (1) The *Platylophus trifolius* consocieties (*vide* Phillips, 1925 : i) in one year may cast litter (per square metre of the crown-influence-zone at the rate of 15–25 ounces.
- (2) The *Podocarpus-Olea laurifolia* type, with dense *Trichocladus crinitus* layer-societies, may in one year cast material with a dry-weight of from 10–15 ounces per square metre.

Remembering that the overwhelming majority of the species and individuals of the forest are “evergreens,” it is seen that the accumulation of litter really proceeds at a fairly high rate.

Although the forests are usually fairly moist, and although there are numerous ground organisms in the upper layers of the humus carpet, the cast foliage of most of the forest trees does not decompose rapidly, principally on account of its coriaceous and semi-sclerophyllous nature.

### Soil Biota.

This field has scarcely been touched at the Knysna, in spite of its possible importance in forestry practice. All that can be done is to record the meagre information available :—

### Bacteria.

The soils of forest and macchia are well populated with bacteria of the genera *Bacillus*, *Micrococcus*, *Proteus*, *Cladotrix*, *Azobacter*, and *Clostridium*; the writer has not yet investigated the parts played by these.

An important species is *Pseudomonas radiculicola* Beijk, which occurs not only in the nodules of the Leguminous species [notably *Virgilia capensis* (tree), *Podalyria*, *Crotalaria*, *Aspalathus*, *Indigofera*, *Cyclopia* species (shrubs)] but also in the root-nodules of *Podocarpus elongata* L’Herit. and *P. Thunbergii* Hook. The occurrence of the organism in the former podocarp is described by Spratt (1912); the writer in 1922 isolated the same organism from the nodules on *P. Thunbergii*. Hook.\*

The part played by *Pseudomonas radiculicola* in the fixation of atmospheric nitrogen is too well-known to be discussed here, but the results of several experiments carried out with the organism are of importance :—

[Nobbe and Hiltner (1899) were able to show experimentally that the cultivation of seedlings of *Podocarpus* was impossible in the absence of the so-called fungus which was thought to produce the nodules; seedlings with nodules, however, were grown successfully for the space of five years in nitrogen-free, quartz sand.]

The writer germinated in carefully sterilized sand and loam, and in control soils, a large number of podocarpia of *P. elongata* and *P. Thunbergii*, and established the following points :—

- (1) *Pseudomonas radiculicola*, in nature, enters into symbiosis with the young plant immediately on germination of the podocarpium.
- (2) Bacteria-free seedlings can be grown in sterile soil for the space of several weeks, but are weak, and finally succumb.

\* December, 1930 : Saxton (S. Afr. Journal of Science, XXVII : 323–25) states he was unable to detect bacteria in nodules of *P. Thunbergii* collected on Table Mountain, but that he found fungal hyphae : he considers Spratt might have obtained different results had she examined species from their original homes; my findings, however, go to support Spratt’s results.

*Pseudomonas radiculicola* Beijk = *Rhizobium radiculicola*.

- (3) Such bacteria-free plants, when supplied with water containing even a portion of the bacterial-content of a single, small nodule, within a few days exhibit the presence of incipient nodules, and gradually are able to assert themselves.

It is clear that the presence of the correct strain of *P. radicicola* in the soil is an essential to the successful establishment of regeneration of both *Podocarpus* spp. Soils lacking in the strain are either entirely incapable of supporting the seedlings, or else do not produce good results in the latter.

No other species of tree or shrub (apart from the Leguminosae) exhibit symbiosis with bacteria.

#### *Protozoa.*

Fantham (1922) describes the Protozoan population of three soil samples from the George District. As his account is the only one relating to Protozoa in the Knysna region, a summary of it is given below :—

No.	Depth of Sample.	Soil.	Site.	Protozoa.
1	Inches. 0-5	Agricultural soil; light-brown and sandy	Gwaayang, 30 ins. rain per annum, elevation 600 ft.	<i>Rhizopoda.</i> <i>Amoeba</i> spp. (6). <i>Heliozoa.</i> <i>Actinophrys</i> sp. <i>Mastigophora.</i> 1 sp. of each of the following :— <i>Peranema</i> , <i>Oikomonas</i> , <i>Bodo</i> , <i>Cercomonas</i> , <i>Entosiphon</i> , <i>Planomonas</i> . <i>Infusoria.</i> <i>Cyclidium</i> sp.
2	0-8	Mountain soil, dark loamy	<i>Pinus insignis</i> plantation soil, Jonkersberg, George; 40 ins. per annum; elevation 1,200 ft. <i>Pinus insignis</i> is poor	<i>Rhizopoda.</i> <i>Amoeba</i> spp. (2); <i>Diffugia</i> sp <i>Euglypha</i> spp. (2). <i>Heliozoa.</i> <i>Actinophrys</i> sp. <i>Mastigophora.</i> 1 sp. of each of the following :— <i>Oikomonas</i> , <i>Bodo</i> , <i>Euglena</i> , <i>Entosiphon</i> . <i>Infusoria.</i> <i>Amphileptus</i> sp. Protozoa present in small numbers only.
3	0-8	Mountain soil, but from another site	<i>Pinus insignis</i> doing well	<i>Rhizopoda.</i> <i>Amoeba</i> spp. (2); <i>Diffugia</i> sp; <i>Euglypha</i> spp. (2). <i>Heliozoa.</i> <i>Actinophrys</i> sp. <i>Mastigophora.</i> 1 sp. of each of the following :— <i>Peranema</i> , <i>Oikomonas</i> , <i>Bodo</i> <i>Cercomonas</i> , <i>Entosiphon</i> , <i>Euglena</i> . <i>Infusoria.</i> 1 sp. each of the following :— <i>Lacrymaria</i> , <i>Colpoda</i> , <i>Cyclidium</i> , <i>Paranocciun</i> , <i>Stylonychia</i> , <i>Vorticella</i> . Protozoa present in larger numbers as regards genera and individuals.

Apart from stating that Protozoa are present in large numbers in forest soils, the present writer is unable to add to the above information concerning Protozoa in the region under study, but Prof. Fantham and the writer have taken up the study of the Protozoa in different soil types.\*

† Since this was written Fantham and Robertson (1928 : 378) has described in some detail the Protozoa determined from soil samples submitted by Phillips from experimental sites and Natural Forest, at Deepwalls. Physical factor data and vegetation descriptions are given.

### *Earthworms.*

These are the only other organisms of prime importance. The indigenous Acanthodrilidae are well represented, and the exotic *Lumbricus rubellus* and spp., and *Allolobophora* spp. are frequent. The indicator value of the earthworms has been referred to by J. F. Phillips (1924 : 283) in an earlier paper. Heavy soils of low pH value (pH 4 to pH 4.9) support less than 10,000 earthworms per acre, to a depth of twelve inches, whereas lighter, better class soils, of pH 5 to pH 6 support from 20,000–40,000 per acre. Soils rich in earthworms are better drained, better aerated, more chemically active, and better suited to agricultural and forestry pursuits, than those showing relatively low numbers of these organisms. The work of Olof Arrhenius (1921) in Java and California, and notes by Edgar Wherry (1924), Barrington Moore (1922), and E. F. Phillips (1923), in connection with acidity-preferences of earthworms are worthy of study. Apparently earthworms at the Knysna are able to live under considerably more acid conditions (extreme of pH 4) than those in Java and America—Arrhenius gives the extreme as pH 6, Moore and E. F. Phillips state pH 5, and Wherry records pH 4.7.

### *Other Organisms.*

The various insects domiciled in the soil—Forficulidae, Coleoptera more especially—have been little worked systematically, but so far as the writer has been able to observe,\* play no very important part in the life of the soil complex.

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\* By means of quadrats in natural vegetation and sowings of seeds; also by the study of decomposition of cast leaves and twigs on quadrats.





## Chapter II.

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CLIMATIC FACTORS AND ZOObIOTIC  
ASSOCIATES.



## CHAPTER II.

## CLIMATIC FACTORS AND ZOOBIOLOGICAL ASSOCIATES.

## A.—CLIMATIC FACTORS.

*Temperature.*

Temperature data for the region are sparse. Readings have been taken at George and Knysna Townships for a number of years, it is true, but the thermometers do not receive fair, natural conditions of exposure, and the readings have been spasmodically taken.

Temperature readings have been taken at Storms River also, but the thermometers have been mounted on a heat-absorbing, strongly radiating concrete foundation, while the readings taken have been non-critical in nature. The data for the three stations are not worthy of publication. Critical readings of properly exposed standard instruments have been taken at Belvidere (34°04' S. lat. by 23°0' E. long.), situated about ten feet above sea-level, and at Deepwalls Research Station (33°9' S. lat. by 23°16' E. long.), situated at an elevation of 1,725 feet, since 1922. In addition, reliable readings are available for one year for Kaffirkop, 1,180 feet, several miles south of Deepwalls, and for one year from Harkerville, situated on the Uplands Plateau, about 650 feet above sea-level (34°03' S. lat. by 23°12' E. long.).\*

The temperature variations within the region are by no means great; indeed the temperature is to be considered as the most equable in Southern Africa. *Excessively high* temperatures never occur, while *high* temperatures are rarely experienced. This is clearly indicated by the available *Solar radiation* temperatures given in *Table IV*, as well as by the *shade* temperatures shown for Belvidere, Kaffirkop, Deepwalls, and Harkerville, in *Table V*.

At the same time, very low temperatures are of very rare occurrence, and when they do occur, are confined to low-lying sites (so-called "frost-holes") and to the higher altitudes. Snow falls but once or twice per year on the mountain-barrier, and at very long intervals on the foothills and upper plateau (vide *Table XXV*).

The reasons for the equable temperature conditions are to be found *firstly* in the geographical position of the area—its shores are influenced by both the cold Benguela and the warm Mozambique currents: and *secondly*, in the general cloudiness [vide *Tables XV* and *XVII (a)* and *XVII (b)*] and high humidity (vide *Table XIX*) which prevent excessive heating during the day and excessive loss by radiation at night.

The *mean* temperatures recorded for Belvidere and Deepwalls are lower than those recorded for centres east and west of the region under discussion, thus :—

Station.	Latitude S.	Longitude E.	Mean Temperature (4 ft. above ground).
Capetown (Observatory).....	33°56'	18°29'	62°00'
Mossel Bay.....	34°11'	22°09'	63°30'
Port Elizabeth.....	33°58'	25°37'	64°00'
Nast London.....	33°01'	27°54'	66°00'
Belvidere.....	34°04'	23°00'	61°90'
Deepwalls.....	33°90'	23°16'	59°30'

\* Position in 1926.

There is a slight decrease in *mean* temperature as the coast is left and the mountain-barrier approached—the littoral proper is 2-3 degrees warmer than the plateaux inland, and the latter  $1\frac{1}{2}$ -2 degrees warmer than the mountain slopes. Readings of temperature taken by means of portable field thermometer sets and compared with thermograms produced by recording thermometers at Deepwalls, show that from time to time the differences in temperature between the littoral and the plateaux may be as much as 10 degrees (warm, dry weather, or cold, windy weather). Further, during the occurrence of strong Föhn-like ("Berg") winds blowing from the north or north-west (*vide* description of these winds, pp. 51-53, this Chapter), it has been shown that the mountain slopes and foothills experience temperatures from 2 to 10 degrees higher than the littoral.

There are marked temperature differences between northern and southern slopes and also between eastern and western ones. Not only are the *mean* temperatures higher on the northern and western slopes than they are on the southern and eastern, but the *absolute* and *mean* ranges are also wider. An example of temperature differences according to aspect, is given in *Table VII*. Standard, screened thermometers were installed at heights of six inches, twenty feet, and forty feet above ground-level\*, on the northern and southern slopes (15 degrees) of the same hill, and at the same elevation above the sea.

The sites were of the same area, and were cleared portions of the forest. From a perusal of the data it is seen that the more severe conditions are experienced on the northern slope. With reference to the height above ground, it is seen that, as might have been expected from theoretical reasoning, there is a steady decrease in temperature as the soil is left.

The influences of forest canopy upon air and soil temperatures have received fairly thorough study at Deepwalls for a period of three and a half years. In *Table VIII* are given the air temperatures nine inches above the soil, on two adjacent sites identical in elevation and aspect, *the one under forest canopy, the other fully exposed to insolation*, through removal of the upper canopy and the lower layers of shrubs, ferns, and herbs. It is readily seen that while the *mean* and *absolute maxima* are considerably higher under full exposure than on the canopied site, the *mean* temperature under full exposure is consistently 3-5 degrees higher, and that there is slight difference between the *mean minima*. Slightly lower *absolute minima* are shown by the exposed site than by the canopied one.

The *absolute maxima* occurring on exposed sites, e.g., such temperatures as 110° F., 105.5° F., 103° F., are responsible for the death of numerous young plants of tree and shrub species.

When such temperatures are accompanied by low humidity (15-25 per cent. R.H.) and by strong wind, the wilting of fully exposed branchlets of pole and of adult trees is brought about. Flower buds and young fruits, too, are at times severely scorched.

The *absolute minima* on exposed sites, on the other hand, rarely have an influence detrimental to plants, unless the sites be markedly low-lying and thus be subject to frost.

The influence of forest canopy upon the temperature of the superficial layers of the soil is well brought out in *Table IX*, wherein two adjacent sites at the same elevation and on the same aspect, *the one under forest canopy, the other fully exposed to insolation*, are contrasted in terms of *mean* temperature, and *absolute maximum* temperatures, at depths of one-quarter and six inches. The thermometers at the quarter-inch depth were standard, cylindrical-bulbed instruments, the bulbs being encased with a thin layer of thick linseed oil (renewed several times per week) to insure successful adhesion of the soil

\* *Vide* Plate 74.

particles: the rest of the tubes were protected from the sun by means of a raised, aerated wooden case. The bulbs were placed slightly below the rest of the tubes. The instruments used at the six-inch depth were standard, cylindrical thermometers, their bulbs being encased in a second glass tube containing parawax, the object of this coating being to insulate the bulb against sudden fluctuation in temperature resultant on the thermometer being pulled up from the soil for reading. (The parawax enables the observer to study the thermometer scale for several minutes without fear of the mercury changing its position.) The thermometers were housed in wooden tubes sunk in the ground to the required depth.

From *Table IX* it appears that the *mean* temperature one quarter of an inch below the surface, at 1 p.m., is considerably higher on the exposed site than it is under canopy, while the *mean* temperature at 7 p.m. is slightly higher, the difference being more pronounced in the summer months. (An exception is noted in the instance of 7 p.m. mean, June, 1925, when the temperature under canopy was  $0.8^{\circ}$  F. higher than in the open.) It is superfluous to point out that the *absolute* maximum at 1 p.m., under full exposure, is appreciably higher than that under canopy. The *absolute* maximum at 7 p.m. is slightly higher under full exposure, the differences being more marked in the summer months.

The great decrease in temperature with increase in depth of five and a half inches, is noteworthy. At the same time, the *absolute maxima* six inches below the surface, under full exposure, are of some magnitude:  $76.0^{\circ}$  F.,  $77.75^{\circ}$  F.,  $79.0^{\circ}$  F., and  $80.5^{\circ}$  F. The *mean* temperature at 7 p.m. is slightly greater than that at 1 p.m., under full exposure and under canopy alike (with the exception of the records for January and February, under canopy). It is clearly shown, also, that the *absolute maxima* under full exposure, at 7 p.m., are greater than those at 1 p.m.: the same applies to most of the *absolute maxima* under canopy. The reason for this interesting occurrence seems clear: the heat absorbed by the superficial layers of the soil during the warmest hours of the day—usually between 12 noon and 4 p.m. in summer, and between 1 p.m. and 3 p.m. in winter—is slowly conducted downwards, naturally losing much of its intensity as it progresses from the surface. The heat intensity conducted to the depth of the six-inch thermometer is naturally less at 1 p.m. than that conducted by any hour later in the day, unless there be a sudden downpour of rain or unless a cold wind spring up. The temperature at the quarter-inch thermometer, on the other hand, is almost coincident with that of the air immediately above the surface—that is, a sudden fluctuation in air temperature is within several minutes reflected by the temperature at a quarter-inch below the surface. There is a definite lag of from one hour to several hours (seven at times), in the instance of the six-inch instrument, but the current air temperature has been noted to produce an effect upon this instrument before 8 p.m. of the same day. The subject of lag at greater depths is referred to further on in this Chapter (*vide* p. 43).

Of interest in connection with the subjects of canopy influence and of lag in superficial temperatures are the examples of bi-hourly records of soil temperature one quarter of an inch and six inches below the surface, with accompanying maximum, minimum, and mean air temperatures nine inches above the soil, given for a *fully exposed site* and for *one under canopy*, in *Table X*. Records for a typical summer day and for a typical winter one are selected. At the three levels the difference between exposed and canopied sites are more marked on the summer day than on the winter. While, generally speaking, the differences at one quarter of an inch below and at nine inches above the soil, are more marked during the warm portions of the day, the differences at the six-inch depth are greater during the later hours.

Tables XI and XII contain examples of temperature conditions at greater depths, both under high canopy and on an adjacent area experiencing the same aspect and at the same elevation, but fully exposed to insolation. The instruments used were standard soil thermometers, their bulbs encased in parawax, and their tubes rubber insulated; they were placed in standard metal tubes supplied by Negretti & Zambra. The data are of interest for their own sake, and because they are the first deeper soil temperature records obtained for a South African forest. The only other soil temperature data published in connection with South African forestry are those of Sim (1907 : 36) taken at Fort Cunynghame under cover of oak, eucalypts, pines at depths of one foot respectively. Apart from minor seasonal irregularities the data in Table X indicate that under full exposure and under canopy alike in January, February, March, November and December there is a *slight decrease in temperature as depth increases*, whereas in April, May, June, July, August, September and October, there is a *slight increase in temperature as depth increases*. Furthermore, in January, February, March, April, September, October, November, and December, the temperatures at one foot and at two feet are *higher on the exposed site*, while in May, June, July and August, they are *slightly greater under canopy*.

Table XI giving examples of hourly readings of soil temperatures *under canopy* and *under full exposure*, for a typical summer day and a typical winter one, clearly shows that *on the summer day there is a decrease in temperature with increased depth*, and that *on the winter day, there is an increase*. It is seen, also, from the diurnal and nocturnal means, that the *mean temperatures at night at one-foot and two-feet levels are very slightly higher than those of the day*. Finally, it is to be noted that the *mean temperatures* (diurnal and nocturnal) *on the exposed site are slightly higher than those under canopy*, but that the summer day means are higher on the exposed site.

The *mean range* decreases with depth, thus, under canopy we find the *mean ranges* to be as follows :—

Depth.	Year.	Mean Maximum. F.	Mean Minimum. F.	Mean Range. F.
1 foot.....	1923	60.44 (March)	51.55 (July)	8.89
	1924	60.21 (Feb.)	51.05 (Aug.)	9.16
	1925	61.38 (Feb.)	52.30 (July)	9.08
2 feet.....	1923	59.91 (March)	52.27 (Aug.)	7.64
	1924	59.63 (Feb.)	52.24 (Aug.)	7.39
	1925	60.83 (March)	53.47 (July)	7.36
4 feet.....	1923	59.21 (March)	52.94 (Aug.)	6.27
	1924	59.04 (Feb.)	53.02 (Sept.)	6.02
	1925	60.19 (March)	53.97 (Aug.)	6.22

On the exposed site the same principle applies, the mean ranges being wider :—

Depth.	Year.	Mean Maximum. F.	Mean Minimum. F.	Mean Range. F.
1 foot.....	1923	62.98 (Dec.)	50.35 (Aug.)	12.63
	1924	64.54 (Dec.)	47.91 (July)	16.63
	1925	65.00 (Jan.)	50.31 (July)	14.69
2 feet.....	1923	62.43 (Dec.)	51.43 (Aug.)	11.00
	1924	64.09 (Jan.)	49.66 (July)	14.43
	1925	64.17 (Feb.)	51.57 (July)	12.60

A feature of interest connected with the deeply placed thermometers under canopy is the *well defined lag of the soil temperatures behind the air maximum and minimum temperatures*. It has been observed repeatedly that: (a) the one-foot thermometer in the evening reflects, to some extent, any extreme shown by the air temperature of the same day, but at 8.30 the following morning does so more clearly; (b) the two-feet thermometer in the evening does not reflect any extreme shown by the air temperature of the day, but to some extent does so at 8.30 the next morning; at 1.30 p.m. of the day following the extreme shown by the air temperature, a more definite reflection is shown, and by 7 p.m. this has become clear—thus a lag of from twenty-four to thirty hours is the rule; (c) the four-feet thermometer shows a lag even more pronounced—varying from thirty-six to forty-eight hours.

The thermometers on the exposed site do not show such protracted lag, the periods for the one-foot and two-feet instruments being quite six to twelve hours less than for their fellows under canopy.

From other soil thermometer observations taken at Deepwalls and from phenological studies, it seems that apart from the severe temperatures of the superficial layers of exposed sites, soil temperature changes little influence plant life within the Knysna region. Extremes do not occur, and the summer and winter means differ but little. *The high temperatures of the surface soil of exposed sites, however, play a most important role in plant succession*. Seedlings of most tree and shrub species and of many undershrubs and herbs, are lesioned at the collars by the severe surface soil temperatures. The dryness of the soil and the low humidity of the air immediately above the soil assist the heated surface in burning constrictions at the seedling collars. The insolation lesion is identical in appearance with the work of *Pestalozzia Hartigii*, Tubeuf, ("Einschnürungskrankheit"), and in Europe, the United States of America, and South Africa has been confused with the latter at every turn. Touney and Neethling (1923 and 1924) working at the University of Yale Forestry School, have gone carefully into the literature, and also have experimentally proved that the constrictions or "lesions," are produced by high soil temperatures accompanied by low soil moisture content. The present writer, working with seedlings of various Knysna trees, in 1922–1923 independently, found that it was possible to lesion plants by exposing them to either natural or artificially produced insolation of relatively high intensity. The tree seedlings were found to vary in degree of resistance to lesion formation, in accordance with the list given below:—

Most resistant.....	[Do not lesion unless surface soil contains less than 3 per cent. (dry weight) moisture, and unless temperature exceeds 165° Fahr. for over half hour.]  <i>Virginia capensis</i> seedlings in all stages; seedlings of all other Forest trees when well-lignified and of more than 1-inch diameter at the collar; especially large vigorous plants of <i>Podocarpus elongata</i> L'Herit; <i>Curtisia faginea</i> ; <i>Canonia capensis</i> .
Moderately resistant...	(Do not lesion unless surface soil contains less than 3 per cent. moisture, and unless temperature exceeds 160° Fahr. for over half hour.)  All seedlings (except <i>Apodytes dimidiata</i> , <i>Podocarpus Thunbergii</i> , Hook; <i>P. elongata</i> , L' Herit) on becoming slightly lignified at the collar (3 to 6 months of age). Slightly lignified <i>Apodytes</i> is delicate, but slightly lignified <i>P. elongata</i> and <i>P. Thunbergii</i> are able to resist higher temperatures than other spp. of the same age.
Lesion readily.....	(If the soil moisture at the surface of the soil drop below 3 per cent. and the temperature be greater than 150° Fahr. for more than half hour.)  All seedlings on first appearance from seed (except <i>Virginia capensis</i> ), but particularly <i>Platylophus trifolius</i> , <i>Canonia capensis</i> , <i>Ekebergia capensis</i> , <i>Kiggelaria africana</i> , <i>Olea laurifolia</i> , <i>Fourea McNaughtonii</i> , <i>Apodytes dimidiata</i> , <i>Ocotea bullata</i> , <i>Elaeodendron croceum</i> , <i>Podocarpus</i> spp.

There is naturally much variation according to soil colour (dark soil heats up more readily than light coloured), soil texture, (closely packed, fine soil absorbs and retains more heat than coarse, open soil) soil moisture (the drier the soil the lower the temperature at which plants lesion), aspect (northern and north-western aspects are the most severe), and nature of the individual seedling. In nature, many thousands of young plants appearing on insolated sites in exploited or burnt forest, or along exposed portions of the margins, are killed by the high surface temperatures: the influence upon succession is thus a potent one.

It is of importance to note [*vide Tables IV, V, VII, VIII, and IX*: the temperature records, in italics, were obtained on "Bergwind" days] that the *absolute maximum* temperatures are usually coincident with the occurrence of the hot, dry Foehnlike, north or north-western winds known within the region as "Bergwinds."

While frosts are of relatively rare occurrence in all parts of the region except the lowest lying, its classification as *an area of no frosts* (*vide* Frost Maps: Drought Commission Report, 1923), is not strictly correct. Low-lying sites—river valleys, ravines, large and small depressions between the hills—certainly experience severe frosts between May and August of each year. In certain localities, the frost may remain in position until as late as mid-day, owing to its receiving a comparatively slight amount of direct sunlight. Very rarely highly situated, exposed sites in the midst of the forests experience frosts of mild nature. The general country-side, however, does not experience frost. Since January, 1923, frosts have been recorded at the Deepwalls Research Station, 1,725 feet, situate on a hill rising out of the main forest; the summit of the hill has been cleared of forest. Observations have also been made at Belvidere, ten feet above sea-level. The data are submitted in *Table VI*.

Severely frosted foliage of certain species, e.g., of *Ocotea bullata*, *Apodytes dimidiata*, *Platylophus trifolius*, *Canonia capensis*—usually suffer, especially if direct sunlight reaches the crowns at an early hour of the morning. The likelihood of damage being done is much increased if a wind spring up. Insolation-protected foliage suffers little.

### *Light.*

Sunshine observations and light-intensity measurements were commenced by the writer in January, 1923: apart from the data thus collected there are no records for the region.

For conveying an idea of the amount and nature of the daylight available within the region, the data given in *Tables XIII* (average possible number of hours direct sunlight, by weeks, Deepwalls), *XIV (a)* (actual hours of direct sunlight per mensem, Deepwalls), and *XIV (b)* (average number of hours actual direct sunlight, Deepwalls, per diem) are useful.

From *Table XIV (b)* it is seen that the ratio of *possible* hours of sunlight: *actual* hours of sunlight, for the year is as 100:59.

In this connection, the data—comparison of duration of direct sunlight for several centres in South Africa and overseas—in *Table XV*, are of interest.

The ratio of *direct, diffused* light is approximately 4:1, there being no practical change in the ratio with season (*vide Table XVI*).

The condition of the sky at Deepwalls, at the hours of 8 a.m., 1 p.m., and 7 p.m., has been recorded for three years; for sake of example, the monthly averages of cloudiness at these hours are given (*Table XVII*) for the year 1925. [(0 indicates a cloudless sky, 1 a sky one-tenth clouded, 10 a fully clouded (ten parts out of ten) sky, and so on.)] In *Table XVII (b)* the degree of cloudiness for several centres in Cape Province and for the coast-belt of Natal, is compared.



The light, in filtering through the various forest layers is naturally much decreased in intensity ere it reaches the forest floor. The values given in *Table XVIII* for this reduction in light-intensity, are representative of hundreds of measurements made per Clements's Stopwatch Photometer (Clements, F. E.: 1905: 38-63). The various criticisms to which the use of the photographic method of light comparison is open are well known to the writer, but it can be argued that there are just as many disadvantages occurring from the use of the photochemical methods such as Ridgway's Oxalic Acid Method (Ridgway, C. S.: 1918: 234), and the Potassium Iodide and Sulphuric Acid Method (*vide* Braid, K. W.: 1923: 54-59, for description and refs.; also Bews and Aitken: 1923: 33-44). With reference to the photographic method it is admitted that a great disadvantage is that no expression of the light-intensity in absolute terms is possible; at most, an impression of the relative densities of canopies can be obtained.

The general criticism advanced is that the quality of the light is modified in passing through the leaves of the various layers—the yellow and green being absorbed to a lesser degree than the red and blue violet and ultra-violet rays—and that therefore as the photographic paper is really darkened by the highly refrangible blue, violet, and ultra-violet rays, the light values obtained by its use are very much too low. Spectroscopic study of the light in forest has been made, principally by Zedebauer (1907: 325-330); and Knebel (1914, 1915: 90), certainly shows that the light is *very slightly modified* as it passes from layer to layer. It must be admitted, however, that the greater proportion of the light reaching the floor is not *transmitted* through the leaves, but is *direct and diffused light that passes unchanged in quality*, between the leaves.\*

In the instance of the *Podocarpus* spp. at the Knysna, the amount of light passing through the leaves is insignificant, light within the crowns of these trees and below them being *practically unaltered white light*. Thiek, dark-green, more or less horizontally placed leaves such as those of *Olea laurifolia*, *Pterocelastrus variabilis*, *Cunonia capensis*, and *Ocotea bullata*, transmit slightly more light than those of the *Podocarps*, the greatest transmission being shown by such species as *Apodytes dimidiata*, *Rhus laevigata*, *Celtis rhombifolia*, *Plectronia Mundtii*, and *Halleria lucida*. Even the ground vegetation, consisting largely of *Trichocladus* shoots, of *Hemitelia* and of other ferns, transmits exceedingly minute amounts of light. On the whole, reduction in amount of light is very considerable, change in quality, slight, and it is doubtful whether the slight change in quality has any appreciable influence upon plant growth, for photosynthesis principally takes place in the usually not considerably cut down blue and red rays; very considerable change in the composition of the light would have to be brought about ere this function was much influenced.

The only light-intensity data hitherto available for South African forests are those of Bews (1912) and of Bews and Aitken (1923: 41-43).

The present writer for three years has been working on the subject of relative light requirements of the more important forest trees of the Knysna, employing experimental light-intensity screens. The data obtained are to be published at a later date.

#### *Humidity and Precipitation.*

(a) *Humidity*.—The same remarks apply to the readings of dry and wet bulb thermometers constituting the standard hygrometers of the Union of S.A. Meteorological Office as to the readings of the maximum and minimum thermometers; the data available from the stations at George, Knysna, and Storms River are unsatisfactory and contain many blanks.

\* Observations, by means of a simple spectroscope (direct vision), made by the writer certainly support this view. The subject requires special investigation.

Since 1923 reliable observations have been carried out at Deepwalls Research Station and at Belvidere; in addition one year's data are obtainable from Kaffirkop, and one year's from Harkerville.

At Deepwalls humidity data have been collected under various conditions of canopy and on several aspects, while relative humidity hygrograms produced by a recording hair hygrometer are available for the base station. More recently an Assmann psychrometer has been used for the measurement of humidity under field conditions.

In *Table XIX* humidity data for Deepwalls, Belvidere, Kaffirkop, and Harkerville are given, while in *Table XX* the humidity of two sites on the northern aspect of a hill at Deepwalls is compared—*one site being under forest canopy, the other experiencing full insolation*. *Table XXA* sets forth the occurrences of relative humidities lower than 40 per cent for the stations described in *Tables XIX* and *XX*.

As examples of the weekly run of humidity, two hygrograms by a hair-hygrograph situate at Deepwalls under full exposure, four feet above the ground, are given—No. 1 for a typical week without "Bergwinds," No. 2 for a typical "Bergwind" week. Both hygrograms bring out the general high humidity of the region, while No. 2 graphically indicates the influence of the "Bergwind" in reducing atmospheric humidity.†

Within the humid region under study, any sudden drop in humidity or any prolonged period of low humidity, produces scorching of foliar shoots and of inflorescences of exposed plants, and wilting and death in exposed or partially-exposed seedlings of the more delicate spp. In this connection the responses made by a forty feet high *Olinia cymosa* and by a fifty feet high *Ocotea bullata*, to falls in humidity (during "Bergwind" weather) is well shown in the three dendrograms attached. These were produced by a MacDougal Dendrograph.\* The rises and falls in the traced line indicate diameter increases and decreases respectively, and it is noteworthy that marked falls in diameter are coincident with marked falls in humidity, while marked rises in diameter are to be correlated with high humidity.†

(b) *Precipitation*.—The rainfall within the region is fairly well distributed over the months of the year, there being no marked wet or dry periods.

The geographical situation of the region, lying as it does between regions of winter and of summer rainfall, is undoubtedly responsible in high degree for this regular distribution.

The key to the distribution of the rainfall west and east of the region is to be found in the positions, movements, and behaviour of the permanent regions of high barometric pressure (anticyclones) lying off the west coast of Cape Province and off the east coast of the country, between it and Australasia. In addition to the usual monthly lateral movements, these anticyclones with the annual movement of the sun, move northward and southward. In April and May the lateral movement of the western anticyclone is eastward, that of the eastern, westward and coastward. Simultaneous with these movements is the advent inland of a large secondary anticyclone, the pressure of this "high" increasing for several months, i.e., until about July. The western and south-western coastal regions of the Cape Province, as a result of the movement northward of the zone of low barometric pressure, experience in winter, rain-bearing, western winds associated with the depressions belonging to the system of low-pressure to the southward. The reason that these western winds do not water a larger area of ground is that they arise in and blow over portions of the Atlantic Ocean which possess a relatively low temperature, and therefore do not take up large amounts of moisture.

\* *Vide* Phillips, 1927; (5) for details; the instrument was kindly supplied by Dr. I. B. Pole Evans.

† *Vide* Diagrams 1-13.

What they do contain is speedily expended on its being condensed against the slopes of the plateaux. Within a few months—during September and October—the anticyclone inland migrates to the Southern Indian anticyclone, the latter then proceeding eastward to its summer position immediately off the West Australian coast, and the South Atlantic zone of high pressure lying just off the west coast of Cape Province. Associated with the Indian cyclone are the rainbearing N.E. and E. winds which supply the summer rainfall to the greater portion of Southern Africa. Unlike those associated with the cyclones of the western coast, these winds originate in a warm ocean, and carrying a considerable amount of moisture, precipitate the larger portion of it as they traverse the plateaux of the interior. The region under special study receives rainfall from winds associated with both the western and the eastern permanent cyclones just described.

The region is classified by Buchan (1897) as being partly of the 20–30 inches-per-annum type and partly of the 30–40 inches-per-annum type (mean annual rainfall), and by Cox and Marloth (1923: Map No. 2), as partly of the 25–35 inches-per-annum type and partly of the 35–50 inches-per-annum type.

In *Table XXI* are given rainfall averages for fifteen stations in or just beyond the borders of the region, together with the average numbers of rainy days (more than 0.01 inches in 24 hours) per annum.

Mossel Bay, immediately west of the region, Uniondale north to north-east of it, and Humansdorp immediately east of it, show average catches lower than any in the region if the catch on the littoral at Plettenberg Bay be excepted. In *Table XXIII* are given monthly totals for five stations within the region, for the years 1923–25.

Reference to the positions of these stations reveals the fact that there is a steady increase in catch as the higher altitudes, on the upper plateau, are approached. It is a matter of common experience that sunshine may prevail at the littoral, while either dense mist envelops the upper plateau and the mountain barrier behind it, or rain actually is falling thereon.

Mists are of frequent occurrence in the higher portions of the region—at altitudes ranging from 1,000 feet upward. These hydrometeoric mists (*Nebelreissen*) contribute very appreciably to the total moisture catch, for they precipitate large amounts of moisture upon cool surfaces such as vegetation in its various forms, and on outcrops of rock along the mountain faces. Usually these mists are accompanied by either south-eastern or north-western winds, ranging from 1 to 3 force, Beaufort Scale. So dense are they at times that objects a yard distant are scarcely discernible. Immediately the mists envelop the forests, condensation takes place, and within a few minutes a steady drip of moisture from the foliage sets in.

Outside the forest at the same time condensation takes place on the plants of the macchia, but unless these be fairly high, the observer may remain perfectly dry, whereas within the forest he would have been drenched within a short space. In a word, forest on account of its greater height, condenses more moisture during misty weather, than does the shorter macchia. It is obvious then that rainfall measurements based upon readings of ordinary, fully exposed gauges, do not truthfully reflect the total amount of moisture actually falling to the ground. Marloth (1903: 403–408; 1905: 97–105) studied this interesting subject a number of years ago on Table Mountain, in connection with the south-eastern clouds.

He used two 5-inch raingauges, one of which bore a one foot-high framework made of netting-wire and of four vertical wire supports, through which framework seventeen *Restionaceae* stems were drawn, the other being an ordinary control gauge. Summarizing, we learn that the control gauge registered in

56 days approximately 4 inches of water, the condensation gauge, 80 inches—or approximately an increase of 1,500 per cent on the control. The difference amounted to 300–400 per cent. during ordinary precipitation, but during misty weather reached 1,000–1,200 per cent. Marloth (loc. cit.) further showed that the condensation gauge when placed in the midst of *maechia*, caught about 33½ per cent., and when placed in the midst of reeds, 12.5 to 25 percent., respectively, the catch of the open control being taken as 100 per cent. More recently, Horton (1919 : 603–623) and de Forest (1923 : 417–419) working in Albany, New York, and in Maryland, respectively, have paid attention to this subject, but more particularly to the related subject of rainfall interception by plants. Several of their conclusions are worthy of notice : Horton, working with trees, concludes that 40 per cent. of the rainfall is intercepted by them, while the interception loss by large field crops approximates this figure. De Forest's results, together with those of Marloth, lead him to doubt whether an actual interception loss produced by vegetation, does occur. He even favours the opinion that interception gains are the result of condensation, in the instances of certain types of hydrometeors and certain types of vegetation.

The present writer has experimented on both aspects of the subject, and the results are certainly interesting, although a full explanation of them still remains to be found.

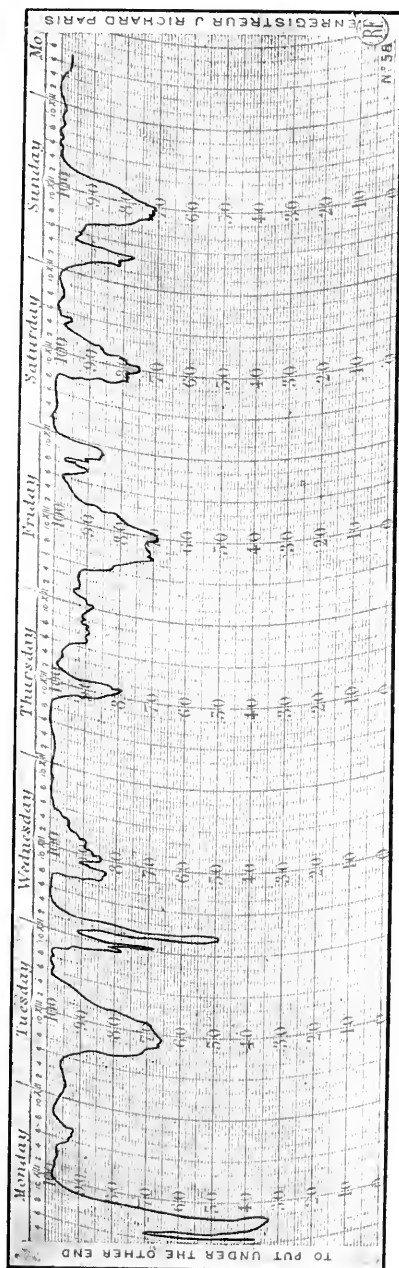
With reference to the condensation of hydrometeors—two 5-inch gauges mounted with their rims four feet above the ground, and ten feet apart, were placed on an exposed hill top at an elevation of about 1,700 feet. The gauges were perfectly free from interfering trees or other objects. One served as a control, the other bore a one foot-high frame of wire and mesh identical with that described by Marloth (loc. cit.) ; through the mesh were drawn four single branchlets of the broad-leaved conifer, *Podocarpus Thunbergii* Hook ; each branchlet bore approximately thirty leaves of from 2–3 inches in length by about ½-inch in width. The branchlets were so arranged that the foliage was held in one and the same position by the wire mesh.

The tops of the branchlets were placed a quarter of an inch below the top rim of the frame. In this manner an evenly constituted mosaic of foliage was exposed all round the mouth of the gauge. Care was taken to keep the foliage in position, but owing to the persistent nature of the material and the toughness of the leaves, practically no alterations were necessary during the course of the twelve months long experiment. Records obtained by means of the gauges are summarized in *Table XXIII*. From these records it is seen that in one year the control caught 52.02 inches of moisture (100 per cent.), whereas the condensation gauge registered 94.56 inches (181.7 per cent.), and that for every month of the year with the single exception of February, 1926, the total was greater for the condensation gauge. From the classification of rain-types the large percentage (79 per cent.) of rains of fine, misty nature, is well shown, normal showers (13 per cent.) and heavy downpours (8 per cent.) being of relatively uncommon occurrence. As it is during the rains of misty nature that the condensation gauge registers the greatest catches as contrasted with the exposed gauge, it is evident that the part played by vegetation in condensing the hydrometeoric mists is a most important one.

From observations the writer agrees with de Forest in the supposition that the degree of interception gain depends upon the amount of water carried past the gauge in a given time, as well as upon the angle of fall and upon the velocity of the wind.

So far as actual interception loss is concerned, the following description of an experiment extending over several years is of interest :—

A 5-inch gauge was erected under canopy of climax forest (*Podocarpus elongata*, *Olea laurifolia*, *Olea capensis*, and *Trichocladus crinitus* formed the



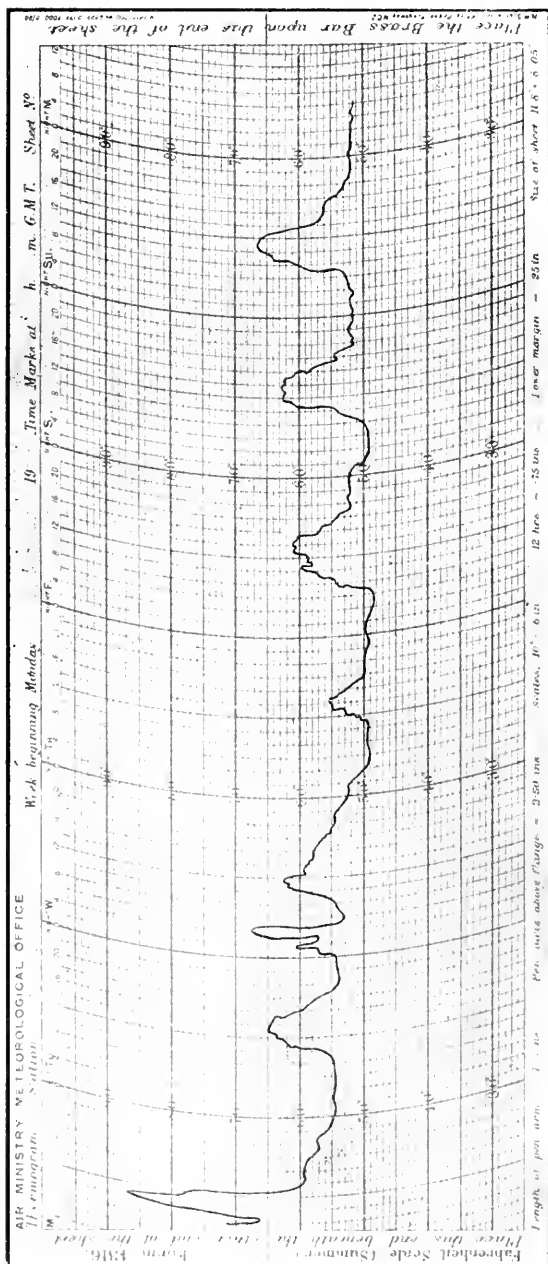
### I. HYGROGRAM No. 135.

Forest Research Station, Deepwells.

(The Hygrogram in a Stevenson Screen 4 ft. above ground.)

An example of the relative humidity conditions during a week without "Bergwinds". (31.8.1925-7.9.1925.)

Tide pp. 46, 52.



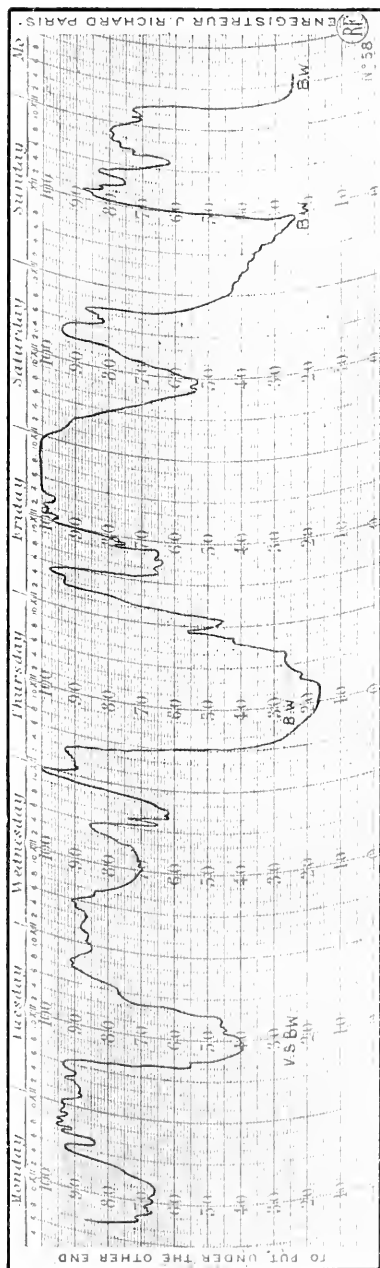
### 1. THERMOGRAM No. 134.

Forest Research Station, Deepwells.  
(The Thermograph in a Stevenson Screen 4 feet above ground.)

#### Accompanying Hygrogram I.

An example of the temperature conditions during a week  
without "Bergwinds". (31.8.1925-7.9.1925.)

vide pp. 46, 52.



## II. HYGROGRAM No. 133.

Forest Research Station, Deepwells.

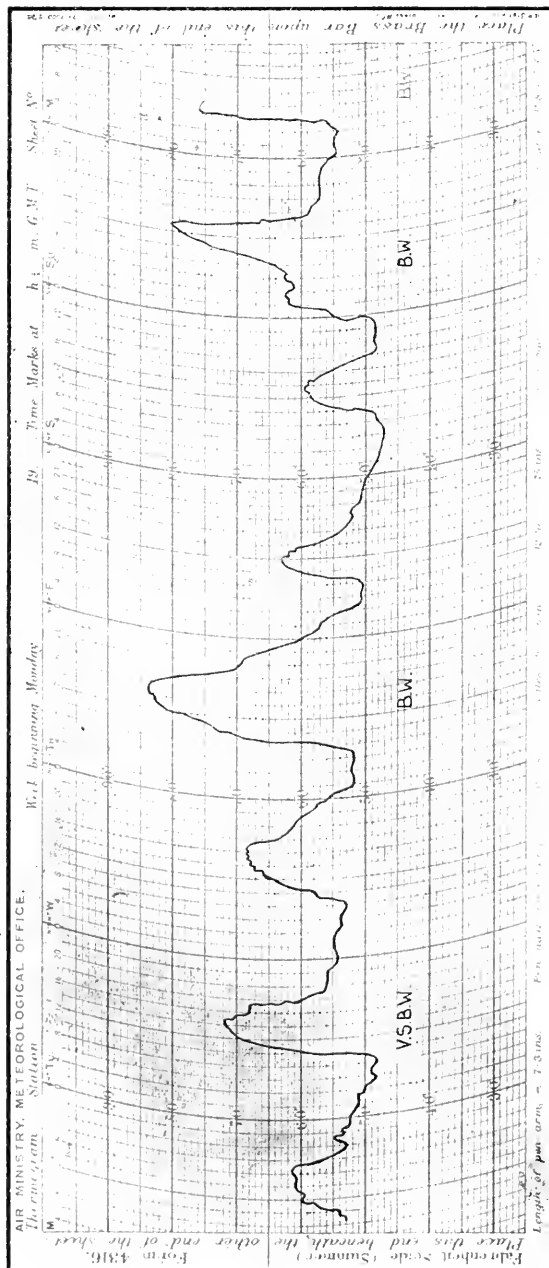
An example of the relative humidity conditions during a week with "Bergwinds". (17.8.1925-24.8.1925.)

*Vide* pp. 46, 52.

B.W.: Bergwind blowing.

V.S.B.W.: Very slight Bergwind blowing.

# IV.



B.W.: Bergwind blowing.  
V.S.B.W.: Very slight Bergwind blowing.

## II. THERMOGRAM No. 132.

Forest Research Station, Deepwells.

(The Thermograph in a Stevenson Screen 4 feet above ground.)

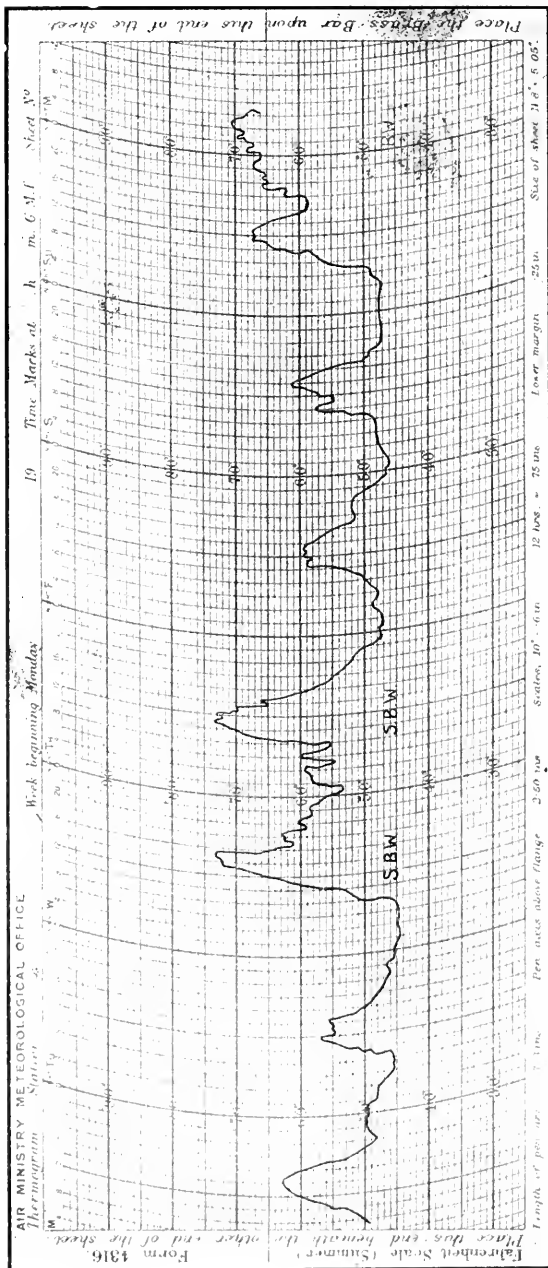
Accompanying Hygogram II.

An example of the temperature conditions during a week with "Bergwinds". (17.8.1925-24.8.1925.)

Vide pp. 46, 52.

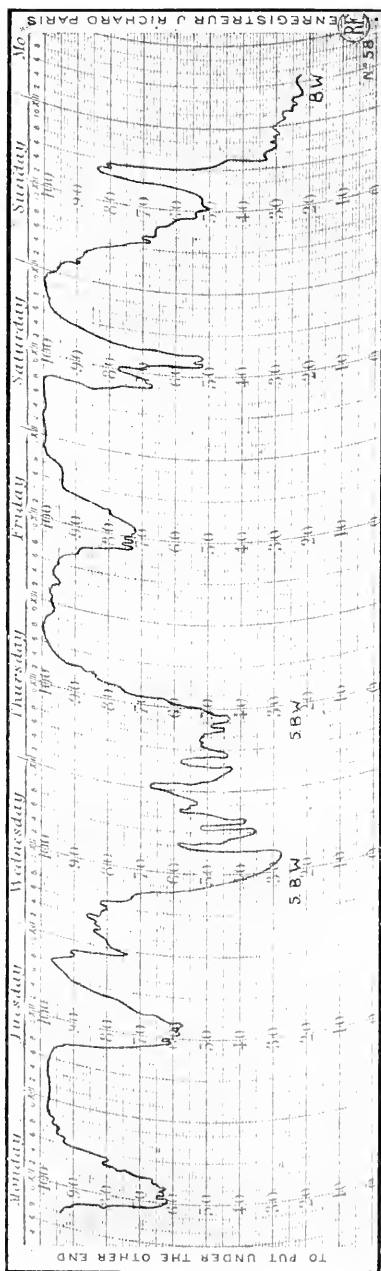






III. THERMOGRAM No. 183.  
Forest Research Station, Deepwells.  
Accompanying Dendogram I.  
(9.8.1926-16.8.1926.)  
*Vide* pp. 46, 52.

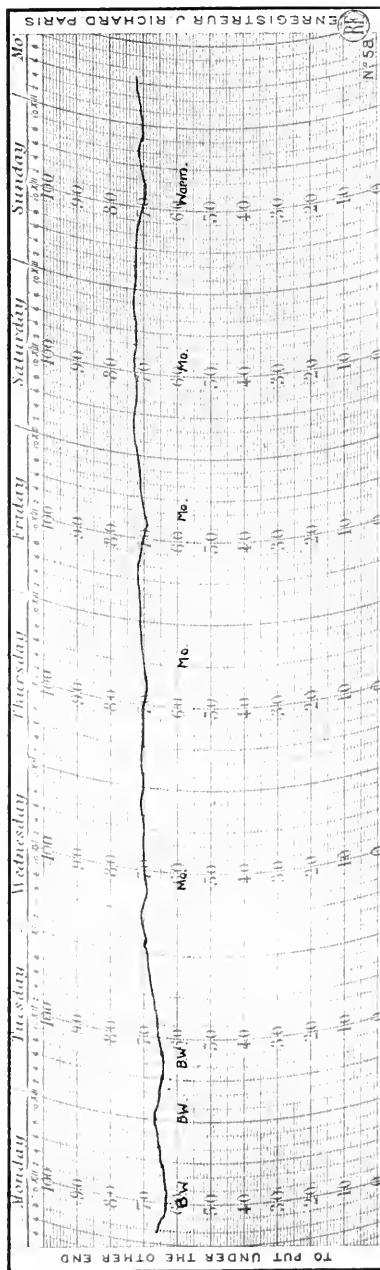
B.W.: Bergwind blowing.  
S.B.W.: Slight Bergwind blowing.



B.W.: Bergwind blowing  
S.B.W.: Slight Bergwind blowing.

III. HYGROGRAM No. 184.  
Forest Research Station, Deepwells,  
Accompanying Dendrogram I.  
(9.8.1926-16.8.1926.)

*Vide* pp. 46, 52.



NOTE.—Diameter variations magnified  $\times 10$ .

B.W.: Bergwind blowing.

Mo.: Moist.

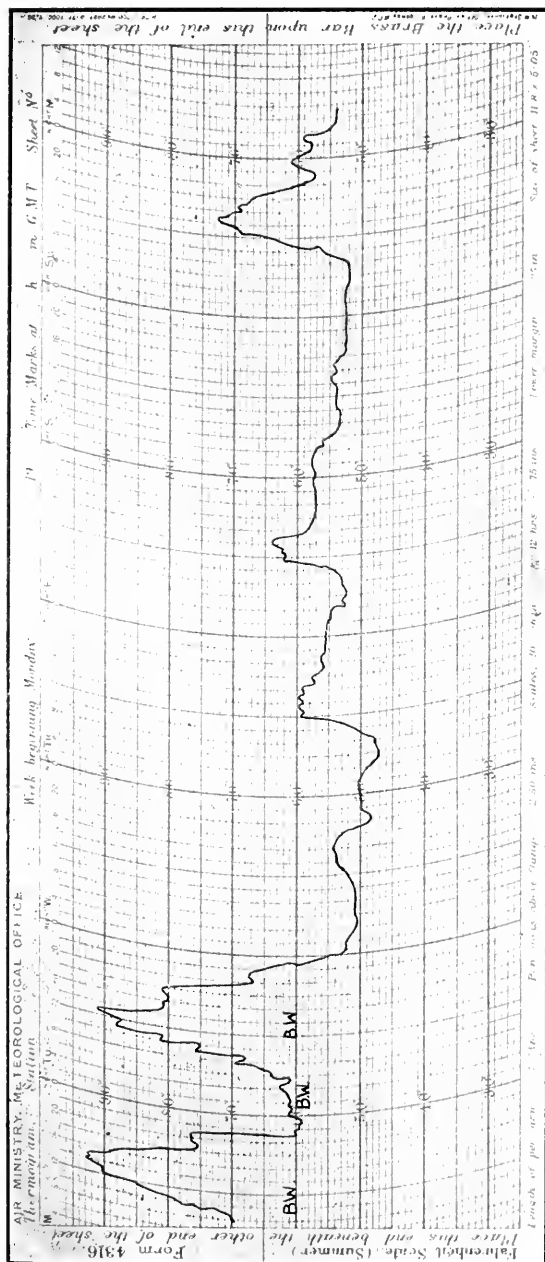
W.: Warm.

II. DENDROGRAM, *Olinia symosa* Thunb. at 4 1/2 ft. from ground.

Forest Research Station, Deepwells.

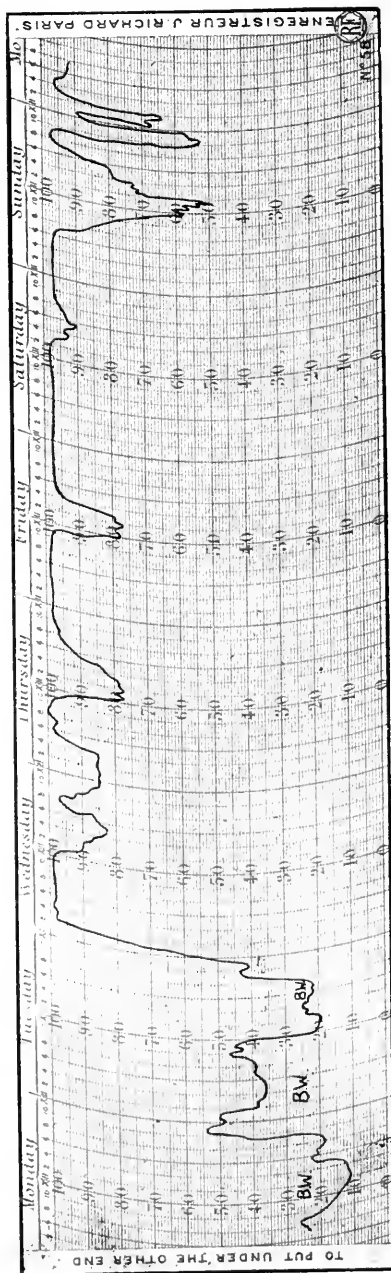
An example of the diameter variations each day during the period 16.8.1926-23.8.1926, and showing the reduced diameter during "Bergwinds".

Tide pp. 46, 52.



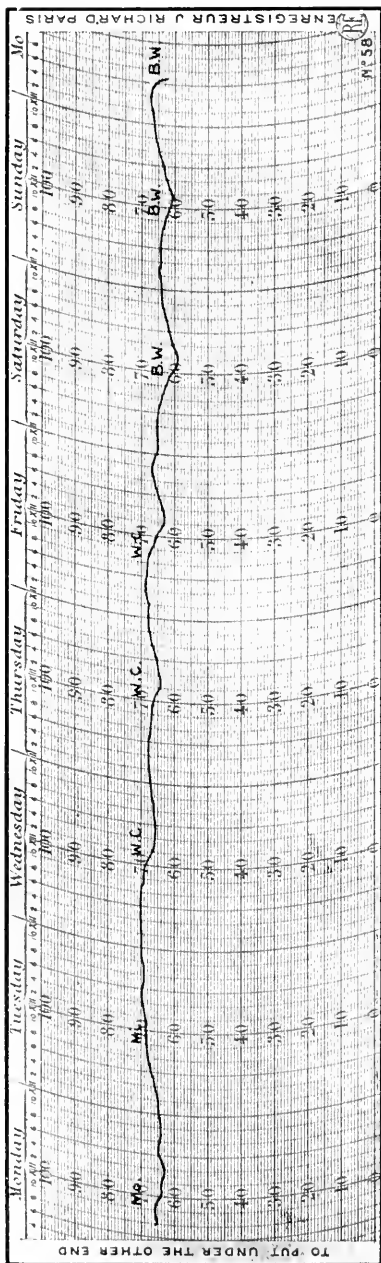
B.W. : Bergwind blowing.

IV. THERMOGRAM No. 184.  
 Forest Research Station, Deepwells.  
 Accompanying Dendrogram II.  
 (16.8.1926; 28.8.1926.)  
 Vide pp. 46, 52.



B.W. : Bergwind blowing.

IV. HYDROGRAM No. 185.  
 Forest Research Station, Deepwells.  
 Accompanying Dendrogram II.  
 (16.8.1926-23.8.1926.)  
*Vide pp. 46, 52.*



NOTE.—Diameter variations magnified  $\times 10$ .

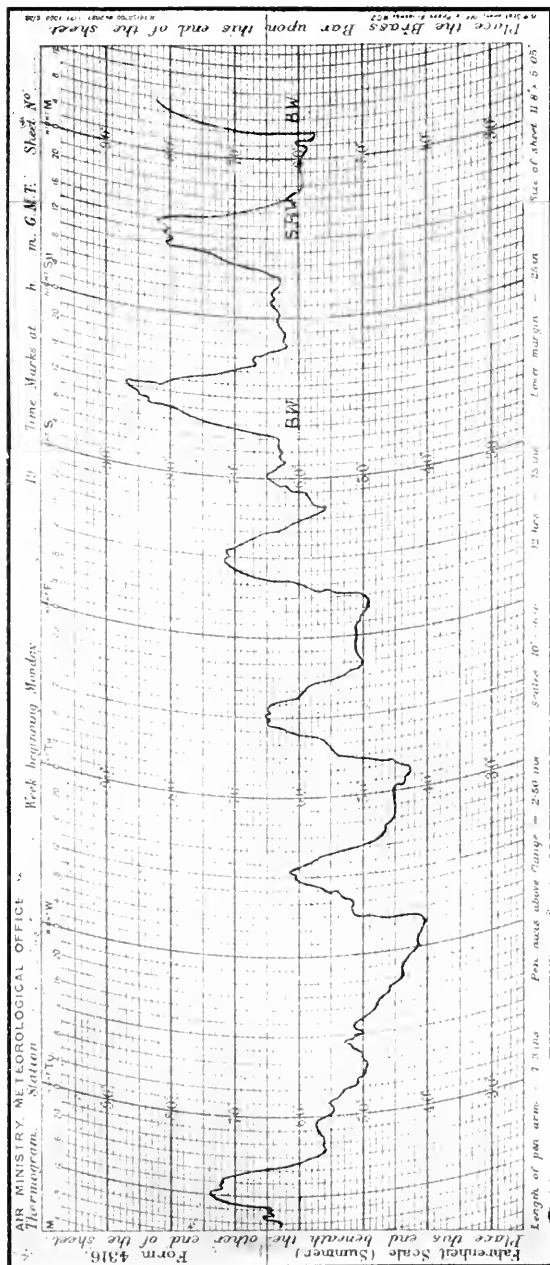
B.W.: Bergwind blowing.  
Mo.: Moist.  
Mi.: Misty.  
W.C.: Warm, clear.

III. DENDROGRAM, *Ocotea bullata* E. Mey, at  $4\frac{1}{4}$  ft. from ground.

Forest Research Station, Deepwells.

An example of the diameter variations each day during the period 4.10.1926-11.10.1926, and showing the reduced diameter during "Bergwinds".

Vide pp. 46, 52.

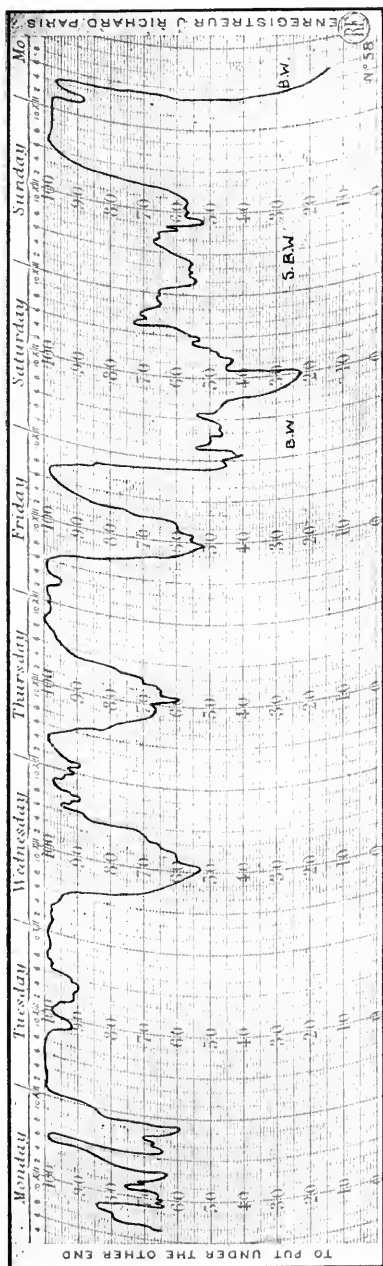


B.W.: Bergwind blowing.  
S.B.W.: Slight Bergwind blowing.

V. THERMOGRAM No. 191.  
Forest Research Station, Deepwells.  
Accompanying Dendrogram III.  
(4.10.1926-11.10.1926.)

*Vide* pp. 46, 52.





B.W.: Bergwind blowing.  
S.B.W.: Slight Bergwind blowing.

V. HYGROGRAM No. 192.  
Forest Research Station, Deepwells.  
Accompanying Dendrogram III.  
(4.10.1926-11.10.1926.)  
*Vide* pp. 46, 52.



actual cover near the gauge), the rim being four feet above ground. The readings taken at 8.30 a.m. were compared with those taken at the fully exposed base gauge, 200 yards distant. In *Table XXIV* the records for the canopied gauge are given, for the period February, 1923–January, 1925 (for monthly totals for the same period for the exposed gauge, vide *Table XXII* “Deepwalls”). For the 11-month-period, February, 1923–December, 1923, the total catch registered by the canopied gauge was 32.84 inches, whereas that shown by the control was 37.63, i.e., these catches are to each other as 87.2 : 100; for the 12-month-period, January, 1924–December, 1924, the catches are 30.85 inches for the canopied gauge and 44.20 inches for the control, i.e., they are to each other as 69.8 : 100. A comparison of the numbers of days with more rainfall than 0.01 inches, for the two gauges reveals the fact that for the 2-year-period, February, 1923–January, 1925, the canopied gauge experienced 58 days less than the control.

The data submitted, together with data still being collected, at Deepwalls lead the writer to differ from de Forest when he doubts the occurrence of interception loss.\*

The subject of total and of efficient rainfall has been receiving some of the attention it deserves—more especially in America (*vide* Drought Commission Report, 1923 : 44–46 for a general account; also Cannon, W. : 1924). At the Knysna, loss of rainwater through run-off is not considerable, owing to the dense cover of forest and of scrub, bush, and macchia. As the country is not a stock-raising one, and as there are numerous, well-distributed watering places for the relatively few cattle and sheep that are kept within the region, but slight damage has been caused by the formation of paths serving as nuclei for the development of “sluits” and “dongas” through the forces of erosion. At the same time it is very necessary to emphasize that where undue burning of macchia and over-exploitation of forest on steep slopes, have been carried out, much local erosion does take place until the pioneer plant communities have recovered the ground. Miniature “bad lands,” the result of severe local erosion, occur on the sites of disused roads descending steep declines.

Lysimetric observations [employing the type of lysimeter suggested by Hilgard (1912 : 227)] made in forest and macchia soils under perfectly natural setting, show that on undisturbed areas the bulk of the fall is absorbed by the porous humus layer, and percolates downward through soil and subsoil. Naturally, localities with steep slopes surrender a certain amount of the fall to run-off, which finds its way to the innumerable streamlets of the region, but the loss so incurred is quite insignificant (less than 5 per cent.) compared with the total annual rainfall. Evaporation losses are discussed under *Evaporation* further on in this Chapter.

Snow and hail as forms of precipitation require mention at this stage.

Snow very rarely falls upon the upper plateau and foothills, but annually falls occur upon the summits of the Outeniqua-Zitzikamma ranges. The snow on the summits seldom lies for more than several days. In *Table XXV* are given snow records for the region for the period 1922–26; during 1926 a heavy fall occurred, covering portions of the upper plateau from three to six inches in snow. Montane Forest patches suffer from snow-breakage annually, the most susceptible species being the flat-crowned *Platylophus* and the brittle *Virgilia*; *Curtisia faginea* and *Apodytes dimidiata* foliage is sometimes desiccated if bright sunshine follow the fall—the foliage turning brown and ultimately falling.

\* *Vide* Phillips, 1926 : (5); 1928 : (3); 1928 : (8) for further notes on condensation and interception.

Hail storms are so few and far between that their occurrence is the cause of popular interest. Large stones (greater than a quarter-of-an-inch in diameter) have not been seen by the writer; the falls are of short duration and of no severity. The damage done to vegetation is altogether insignificant. *Table XXVI* sets forth hail records for Deepwalls.

Thunderstorms are of rare occurrence, the number of storms recorded 1923-25 being as follows:—

*Stations.*—Deepwalls, Kaffirkop, Harkerville.

Year.	Thunderstorms.	Lightning.	Remarks.
1923.....	3	Sheet : slight	Downpour slight.
1924.....	2	Sheet : slight	Downpour moderate.
1925.....	3	Sheet with slight Fork	Downpour moderate.

The lightning seldom strikes vegetation—very occasionally portions of the forests and macchia being “struck.” In forest the work of this factor is very well marked: dead trees standing on small portions of ground on which the ground-vegetation is usually dry.

The subject of influence of drought periods upon the forest formation deserves some discussion.

As the rainfall in the region is comparatively heavy, and is usually fairly well distributed over the months of the year, the vegetation readily shows the effects of even a very short period of drought. Three to four weeks of warm weather without any rain, or with but slight showers, produces detrimental results so far as many of the more mesophytic herbs are concerned; ferns in the least exposed, suffer, while a few of the larger trees (e.g., *Olea laurifolia*) too, reflect the changed conditions in the appearance of their foliage, which either thins out, or yellows slightly, and assumes a wilted aspect. The mosses and lichens in the depths of the forest, too, register the drop in humidity by drying and shrinking. The most notable result, however, is produced in the large, woody shrub *Trichocladus crinitus*, the large, thin, rufescent leaves of which become flaccid on the first signs of drought; death of the plant takes place if the dry weather be prolonged.

While it is exceedingly seldom that the holard\* of forest soil falls within 5 per cent. of the wilting coefficient, death of regeneration of such species as *Ocotea bullata*, *Apodytes dimidiata*, *Platylophus trifolatus*, and *Cunonia capensis* is brought about by reduced moisture conditions under full exposure, and under dense layers of the shrub *Trichocladus*.

Study of the growth-rings of such species as *Podocarpus elongata* L’Herit., *P. Thunbergii* Hook, *Apodytes*, *Elaeodendron croceum*, and *Curtisia faginea*, has failed, so far, to reveal the annual nature of these; some rings seem to be produced in one year, while others appear to be the product of several years, and yet others, the product of several months only. At all events the occurrence of several rings exceptionally close together and almost constituting a single zone, seem to mark the occurrence of periods of minute increment, *possibly corresponding with periods of reduced rainfall*. (Temperature fluctuations are so slight, season for season, that little likelihood exists of their being the causal factor of the formation of these zones.)

A point of great importance is that although the forest and macchia soils are naturally of high moisture content and of relatively heavy nature, they, on exposure to insolation, readily part with the greater portion of their moisture, rapidly pulverizing to a black or pale-grey mass. Under canopy these soils during dry weather, do not retain their moisture for long.

\* Total water-content of the soil, on basis of oven-dry weight.

Exceptional droughts have been recorded for the following years: 1869, 1881, 1891, 1895, 1899. The greatest of these was that of 1868-69; it is recorded that no rain fell for the space of three months, and that "Bergwinds," while exceptionally frequent, were not followed by the customary humid conditions.

By February, 1869, the macchia and the forests were filled with dead and dying plants, and with much inflammable debris. A holocaust by fire was visited upon the region on the 10th and 11th February, resulting in the devastation of thousands of acres of forest (*vide* references given on the vegetation maps for the region), of macchia, and of agricultural land, and in the destruction of human habitations, and in the death of wild and domesticated animals.

1899 saw the second severest drought on record: "Bergwinds" again played havoc with the vegetation for the space of several months, drying it out to considerable degree. Large trees of *Olea laurifolia* and of *Apodytes* died for lack of moisture, while birds and mammals are said to have died in the forests, from thirst.

Few and far between as these drought periods are, it must be remembered that operating through the ages as they have, they must have wielded a potent influence upon forest succession. One extreme season is capable of undoing the growth and development of communities produced by many normal years: direction of succession, too, can be influenced, one type of community of seral nature, being inhibited in its development, another escaping little scathed.

*Wind.*—The prevailing winds are those from the N.W. and S.E.: N.N.W., W. and S.W. winds being less frequent. Periodically the Foehnlike "Bergwinds" parch the countryside. A classification of winds according to direction is given in *Table XXVII*, while they are classified according to their forces in *Table XXVIII* (in terms of the Beaufort Scale, devised by Admiral Beaufort in 1805, and used extensively by all weather offices). The data are based upon observations at 8.30 a.m. and 7.0 p.m. during the years 1924 and 1925—at Deepwalls.

The "Bergwinds," to which frequent reference is made in this paper, require description.

These desiccating winds from the north and north-west are equivalent to those hot winds described by Mann in his "Guide to Natal," and by Bews (1912: 287-289; 1917: 526-527; 1920: 381-382; 1925: 8) for the same region. So far as the Knysna region is concerned, the "Bergwinds" were touched upon by McNaughton (1902) and by Sim (1907: 38), while Marloth (1908: 189) cites observations made by McNaughton.

According to descriptions of the *Chinook* wind occurring east of the Rocky Mountains, by H. M. Ballou (1892-1893: 544-547), of the *Foehn* of the Swiss Alps and of other mountainous regions in Europe and elsewhere, of the *Sirocco* of the Latin countries of Southern Europe, of the *Bora* of Istria and Dalmatia, and of the *Mistral* of southern France, so well given in outline by Hann (1903: 344-365), the *Bergwinds* are related to these as regards general nature of origin and certain major characteristics.

So far as can be ascertained from a perusal of relevant literature and a study of the pressure, temperature, and humidity phenomena occurring immediately before, during, and immediately after a "Bergwind," the peculiar nature of the wind is to be explained as follows:—

As a result of the distribution of barometric pressure, hot winds of low humidity blow coastward from off the warm, dry regions of the Karroo and

the Orange Free State, particularly during the winter months. These winds commence as dry and warm, but by the time they have reached the coastal ranges, after having traversed miles of arid country, they are considerably drier and warmer.

The high humidity and low temperature of the coastal ranges are respectively lowered and increased by the winds from the interior.

In addition to the drying and heating produced in this manner, the air is further dynamically warmed by compression as it descends from the mountains to lower levels to take the place of air which flows out in response to the call of the cyclone or region of low barometric pressure lying off the coast. This increased heating brings about decreased humidity. While it is well known that air descending to levels of higher pressure has its temperature raised by compression—Hann (*loc. cit.*) states at the rate of 1 deg. C. for every 100 metres descent (the average decrease in temperature with rise in altitude being only 0.57 deg. C.)—certain details of this interesting process are veiled in obscurity, *for warm air does not flow downward naturally.*

Observations at Deepwells have established the following points with reference to the hot, dry winds:

- (a) Thirty to forty "Bergwinds" occur per annum: while these are more frequent during the period April-September, they nevertheless do blow during the period October-March.
- (b) The absolute maximum temperatures for the several months of the year, in most instances, coincide with the occurrence of "Bergwinds" (vide *Tables IV, V, VII, VIII, IX*, the temperatures in italics being recorded on "Bergwind" days).
- (c) Days of absolute minimum humidity (or of absolute maximum saturation deficit) are wholly coincident with dates of "Bergwinds" (vide *Hygrograms 1 and 2*, and corresponding *Thermograms* for the same periods).
- (d) Days of absolute maximum evaporation rate are almost wholly coincident with days of "Bergwinds" (vide *Table XXX*, Absolute Maximum Evaporation column, and *Table XXX*, Evaporation on "Bergwind" days).
- (e) Rain frequently follows "Bergwinds"; this appears to be due to the gradual or sudden moving of the wind from N. to N.W., and thence to W. and S.W., or from N.W. to S.W. and W. This veering round is accompanied by gradual or sudden decrease in temperature, increase in humidity, decrease in rate of evaporation; cloud-banks arise on the ocean, and hydrometeors soon appear over the forests of the plateaux. The parching climate of the morning, at noon may be replaced by a fresh, bracing, humid climate not unlike that of the British Isles. The cause of this change of wind direction is not very clear, but in part must be related to the moving N. and W. of the main barometric depression.
- (f) Phytometric studies show that during "Bergwinds" plants, whether exposed or under canopy, transpire at higher rates than they do during the warmest of weather, the air being either comparatively still, or the S.E. wind blowing. The water loss is appreciable, and death of tender plants or of portions of plants is by no means uncommon.\*

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\* Vide *Dendrograms I, II, III.*

- (g) Natural vegetation after several days' "Bergwind" assumes a flaccid appearance. This is much more strongly marked in certain species than in others.
- (h) Together with insolation factors and soil conditions, "Bergwinds" seem to have a controlling influence as to capture of localities by forest. N. and N.W. aspects of severely exposed positions often bear no covering but stunted macchia, while the S., S.W., and S.E. slopes of the same points or ranges are clad in either bush or forest. Even at lower altitudes, and in areas less insolated, well marked *aspect alternes* are found. How far these are to be attributed to "Bergwinds" it is difficult to say, but certainly examples are known where it would seem that the major role is played by these parching air movements.
- (i) The winds are not commonly of high velocity, usually being describable by the Beaufort numbers 1, 2, 3; very occasionally 6 and 7 winds occur; at times winds of force 8 and 9 blow, these assisting in distributing light seeds over fair distances (*vide* Appendix I, Table 4 therein).

#### *Rate of Evaporation.*

Owing to the relatively low temperatures prevailing in the region, and to the usually high humidity of the air, the rate of evaporation is not excessive. During "Bergwind" weather, however, there is an appreciable increase in evaporation rate, owing to the increased temperature, decreased humidity, and the movement of the air. In 1922 the writer commenced the collection of evaporimetric data, employing the ordinary "free water surface" methods. A careful scrutiny of the results obtained decided in their abandonment as being of little utility, and in 1925 the Livingston spherical porous-cup atmometers were substituted (*vide* Livingston: 1915). Fitted with the Livingston-Thone valves (*vide* Thone, F., 1924), these atmometers do not absorb moisture from the wetted exteriors of the porous spheres, through destruction of the minisci in the pores.

In *Table XXIX (a)* are given monthly mean evaporation data (in cubic centimetres of distilled water) for the period July, 1925 to June, 1926, the atmometer being stationed 12 inches above the surface of the soil, under full exposure to insolation, 1,725 feet, Deepwalls Research Station. In *Table XXIX (b)* data for a second atmometer situate under canopy of light-intensity 1/80, and only 25 yards removed from the first instrument, are submitted. From a perusal of the monthly means and of the absolute maximum evaporation losses in 24 hours, it is seen that the losses in the open are consistently of a higher value than those under canopy, despite the slight distance that separates these sites. A feature of the greatest interest is the frequent coincidence of absolute maximum rates of evaporation and "Bergwinds." In *Table XXX* the daily (24-hour periods) evaporation losses registered by the atmometer under full exposure in August, 1925, are given, for sake of showing how the maximum losses are coincident with the occurrence of these parching winds.

Comparison of evaporation losses at the Knysna with those in other portions of South Africa is not possible, for apart from the data given by Cannon (1924), the data regarding evaporation in the Union are practically confined to losses from "free water surfaces" (*vide* Drought Commission Report, 1923: 47), which cannot be compared with data obtained by the Livingston atmometer.

## (B) ZOO-BIOTIC ASSOCIATES.\*

The biotic features of the soil have already been described (*vide* Chapter I, 33-35), the influence of man is discussed in Chapter III, (99-193), while in Appendix I are described the parts played by biotic pollinators and agents of seed dispersal. It remains only to list the more important zoo-biotic associates, and to remark very briefly upon their functions: this is done in *Table XXXI* (pp. 94-96).

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 IMPORTANT FOOTNOTE.

\* Since the above section was written the writer [*vide* Phillips, 1930: (1)] has somewhat developed the *biotic community* concept of Clements and Shelford, and has given examples from the Knysna region. *Plants and animals are considered as inter-related, co-acting, interdependent constituents of an integrated biotic community—that is, animals are not held as being biotic factors external to the plant community: the view of most plant ecologists.*



Table IV.

## SUN TEMPERATURES AS OBTAINED FROM SOLAR RADIATION THERMOMETER WITH BLACK BULB IN VACUO.

Station.	Position.	Temperature, F.	Aug., 1925.	Sept., 1925.	Oct., 1925.	Nov., 1925.	Dec., 1925.	Jan., 1926.	Feb., 1926.	Mar., 1926.	April, 1926.	May, 1926.	June, 1926.	July, 1926.	Remarks.
Deepwells, 1,725 feet	15 ins. above the soil	Mean monthly maximum	99.34	94.21	102.37	107.44	104.99	113.75	108.61	107.99	111.25	96.75	101.96	96.28	
	(Vegetation clad)	Absolute monthly maximum	121.00	122.00	118.00	125.75	121.00	125.00	129.00	125.50	126.00	114.00	120.50	111.75	Grand absolute maximum 129° F.*
Light intensity = full light		Absolute monthly minimum	60.50	70.25	79.25	73.50	73.00	77.75	75.25	74.75	69.00	77.50	72.50	51.75	

Italic Figures denotes Bergwind blowing.

\* On 11-10-26, during a Bergwind (shade temp. max. = 104.5; relative humidity, 11 per cent.) the high sun temperature of 139.75° F. was registered.

Table V.

## AIR TEMPERATURES (THERMOMETERS IN STEVENSON'S SCREENS): READ 8.30 A.M. DAILY.

Altitude and position.	Station.	Temperature, $^{\circ}$ F.	Year.	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year: Abs. Max. Abs. Min.	Remarks.
10 ft. elevation	Beldivere, . . .	Mean max. at 4 ft. above ground	1923	76.40	76.70	79.95	71.36	67.60	65.99	64.40	67.40	67.08	70.06	72.67	75.84		
			1924	77.50	78.00	78.56	71.16	66.13	66.01	66.95	68.44	68.06	67.58	69.79	72.55		
			1925	76.20	81.01	76.93	72.70	70.60	65.23	66.30	69.35	66.98	68.31	71.60	73.91		
2 miles west of Kuyuna		Mean Min. at 1 ft. above ground	1923	58.50	61.20	60.24	55.53	47.80	46.27	45.40	44.90	49.25	54.46	57.70	59.12		
			1924	59.80	60.00	58.91	51.41	46.77	45.32	43.23	44.94	49.65	56.98	55.38	60.75		
			1925	58.80	62.80	61.20	52.30	47.00	45.09	46.00	47.88	51.60	52.25	55.06	57.42		
On edge of Estuary of Kuyuna River		Mean temp. at 4 ft. above ground	1923	67.45	68.95	68.45	63.44	57.40	56.13	54.90	56.15	58.16	62.71	65.18	67.48		62-20 Annual mean, 1923.
			1924	68.65	69.10	61.83	63.78	56.66	55.66	55.09	54.19	57.35	58.78	61.58	69.15		61-23. Annual mean, 1924.
			1925	67.50	71.92	69.06	62.50	58.80	55.16	56.15	58.61	59.29	60.28	63.33	65.66		62-35. Annual mean 1925.
																	61-92. Average for 3 years.
		Absolute max. at 4 ft. above ground	1923	96.60	92.70	84.50	99.70	86.40	81.30	82.60	93.40	92.30	89.30	80.20	86.60	99.70 (April)	
			1924	95.80	91.40	99.10	96.00	80.80	84.90	84.80	78.20	79.50	86.00	80.20	92.50	99.10 (March)	
			1925	81.60	108.00	90.10	97.40	87.40	83.10	81.00	90.40	91.60	79.60	81.20	88.40	108.00 (Feb.)	
		Absolute min. at 4 ft. above ground	1923	54.20	53.00	51.30	45.30	39.60	36.00	37.10	36.70	40.40	45.20	52.20	50.00		
			1924	51.00	52.10	42.80	43.50	39.80	35.50	37.40	36.50	39.90	40.90	45.90	49.20		
			1925	47.50	51.80	52.40	45.80	39.40	38.70	38.20	40.70	43.20	42.50	48.30	51.40		
		Mean range (Average, 1923-24-25)	—	17.00	17.24	16.67	18.99	20.82	20.18	21.00	20.82	16.20	16.72	15.97	16.67		
		Absolute Range, 1923-24-25	—	48.30	56.20	56.30	56.20	48.00	49.40	47.70	56.90	52.40	48.40	34.30	43.30		72-50, Absolute range in 3 yrs.

Italic Figures denote Bergwind blowing.

Table V.—(Continued).

## AIR TEMPERATURES (THERMOMETERS IN STEVENSON'S SCREENS) 4 FEET ABOVE GROUND READ 8.30 A.M. DAILY.

Altitude and Position.	Station.	Temperature, ° F.	Year.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year: Abs. Max. Abs. Min.	Remarks
1,180 ft. elevation	Kafirkop....	Mean max. at 4 ft. above ground	1923	73.09	74.4	73.1	69.0	64.8	63.9	62.1	68.0	65.3	66.8	67.3	72.8		
Exposed hilltop at edge of Main Forest Uplands Plateau		Mean min. at 4 ft. above ground	1923	57.74	55.6	59.4	55.3	51.2	49.8	49.2	48.56	49.9	53.4	55.4	57.0		
		Mean temp. at 4 feet above ground	1923	65.41	64.55	66.2	62.1	57.55	56.08	55.6	58.28	57.06	59.56	61.3	64.9		
		Absolute max. at 4 feet above ground	1923	<i>99.5</i>	<i>98.9</i>	<i>88.8</i>	<i>99.7</i>	<i>82.8</i>	<i>77.2</i>	<i>86.2</i>	<i>81.4</i>	<i>91.7</i>	<i>89.5</i>	<i>78.0</i>	<i>88.0</i>	<i>99.7 (Apr)</i>	
		Absolute min. at 4 feet above ground	1923	52.0	53.1	53.2	41.2	44.5	41.0	39.1	41.0	42.0	45.0	49.0	45.5	39.1 (July)	
		Mean range at 4 ft. above ground	1923	15.35	18.8	13.7	13.7	13.6	14.1	12.9	19.44	15.4	13.4	11.9	15.8		
		Absolute range at 4 feet above ground	1923	47.50	45.8	35.6	58.5	38.3	36.2	41.1	40.4	49.7	45.5	29.0	42.5		

Italic Figures denote Bergwind blowing.

Table V.—(Continued).

## AIR TEMPERATURES THERMOMETERS (IN STEVENSON'S SCREENS) 4 FEET ABOVE GROUND READ 8.30 A.M. DAILY.

Altitude and Position.	Station.	Temperature, °F.	Year.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year: Abs. Max. Abs. Min.	Remarks.
1,725 ft. elevation	Deepwells, (Base)	Mean max. at 4 ft. above ground	1923 1924 1925	— 73-16 74-93	72-94 73-29 74-93	71-60 68-75 72-98	66-69 71-28 68-59	61-46 62-57 66-51	60-33 62-66 60-37	58-70 63-95 61-50	64-85 61-53 62-38	61-10 61-53 62-38	67-87 64-81 65-31	68-26 66-40 68-62	71-25 74-10 71-36		
Exposed hilltop in midst of the Main Forest		Mean min. at 4 ft. above ground	1923 1924 1925	— 58-66 55-46	56-89 56-97 59-63	58-55 53-56 57-83	53-61 54-46 53-15	49-09 49-11 51-28	47-28 47-55 46-22	46-78 48-35 47-19	47-60 47-35 48-94	47-60 47-35 48-94	51-64 48-29 48-77	53-68 50-07 50-44	54-76 57-81 52-56		
De Vlugt Plateau		Mean temp. at 4 ft. above ground	1923 1924 1925	— 65-91 65-19	64-91 65-13 68-89	65-07 61-15 65-40	60-15 62-87 60-87	55-57 55-99 58-89	53-85 55-10 53-29	53-04 56-11 54-34	55-81 53-45 58-86	55-85 54-44 55-66	59-75 56-55 57-04	59-47 58-23 59-53	63-00 65-95 62-46		58-77, Annual mean, 1923, 59-24, Annual mean, 1924, 60-03, Annual mean, 1925, 59-34, Average for 3 years.
		Absolute max. at 4 feet above ground	1923 1924 1925	— 91-25 83-25	94-50 92-25 102-75	84-00 88-00 84-00	94-25 94-50 91-00	76-75 81-75 82-00	73-00 80-25 73-30	74-00 78-25 74-25	86-90 77-25 90-25	88-50 86-00 84-75	84-40 86-50 84-75	76-25 85-00 84-25	88-00 93-25 84-75	94-50 (Feb.) 94-50 (Mar.) 102-75 (Feb.)	
		Absolute min. at 4 feet above ground	1923 1924 1925	— 48-00 46-25	52-00 50-00 51-25	48-50 42-50 51-50	39-10 45-25 46-25	41-40 40-75 41-50	38-50 36-25 40-00	36-00 39-50 37-50	39-00 38-25 40-25	39-00 38-25 40-75	43-20 41-50 36-25	47-00 40-50 43-75	48-25 50-25 47-00	36-00 (July) 36-25 (June) 36-75 (Oct.)	
		Mean range (Average 1923-24-25)	—	16-98	16-96	14-46	15-14	13-58	14-10	13-74	18-01	14-70	16-43	16-36	17-19		
		Absolute range 1923-24-25	—	45-00	52-75	45-50	55-40	41-25	41-75	42-25	52-00	49-50	50-25	45-00	46-25		66-75 = Absolute range in 3 years.

Italic Figures denote Bergwind blowing.

## AIR TEMPERATURES THERMOMETERS (IN STEVENSON'S SCREENS) 4 FEET ABOVE GROUND READ 8.30 A.M. DAILY.

Altitude and Position.	Station.	Temperature, °F.	Year.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year: Abs. Max. Abs. Min.	Remarks.
650 ft. elevation	Harkerville...	Mean max. at 4 ft. above ground	1925 1926	75.1 —	74.8 —	73.6 —	73.2 —	69.5 —	68.4 —	62.5 —	65.2 —	— 64.8	66.1 —	69.7 —	70.1 —		
On margin of Coastal Forest, Up-lands Plateau		Mean min. at 4 ft. above ground	1925 1926	57.2 —	56.7 —	57.3 —	53.6 —	51.1 —	48.2 —	45.1 —	46.4 —	— 47.6	50.0 —	52.8 —	54.4 —		
3 miles from Sea (air line)		Mean temp. at 4 ft. above ground	1925 1926	66.15 —	65.75 —	65.45 —	63.4 —	60.3 —	58.3 —	53.8 —	55.8 —	— 56.2	58.05 —	61.25 —	62.25 —		
		Absolute max. at 4 feet above ground	1925 1926	83.6 —	88.5 —	88.6 —	91.5 —	89.8 —	81.9 —	77.6 —	76.8 —	— 79.9	76.10 —	82.00 —	81.00 —	91.5	
		Absolute min. at 4 feet above ground	1925 1926	51.9 —	52.5 —	46.2 —	44.0 —	41.5 —	40.7 —	37.2 —	35.4 —	— 40.7	43.90 —	45.1 —	48.3 —	35.4	
		Mean range at 4 feet above ground	1925 1926	17.9 —	18.1 —	16.3 —	19.6 —	18.4 —	20.2 —	17.4 —	18.8 —	— 17.2	16.10 —	16.9 —	15.7 —		
		Absolute range at 4 feet above ground	1925 1926	31.7 —	36.0 —	42.4 —	47.5 —	43.3 —	41.2 —	40.4 —	41.4 —	— 18.2	32.30 —	36.9 —	32.7 —		

Italic figures denote Bergwind blowing.

Table VI.

## OCCURRENCES OF FROST, DEEPWALLS AND BELVIDERE, 1923-1926.

Station.	Year.	May.	June.	July.	Aug.	Sept.	Oct.	Total for Year.
Deepwalls (1,725 ft.)...	1923	—	—	—	—	—	—	0
	1924	—	—	—	1 Mild	—	—	1
	1925	2 Mild	—	—	—	—	—	2
	1926	1 Mild	1 Mild	—	—	—	—	2
Belvidere (Sea-level)...	1923	—	—	—	—	—	—	0
	1924	—	—	—	—	—	—	0
	1925	—	—	—	—	—	—	0
	1926	—	—	—	—	—	—	0

## SOUTH ASPECTS OF DEEPWALLS HILL.

y, 24.	June, 1924.	July, 1924.	Aug., 1924.	Sep., 1924.	Oct., 1924.	Year. Absolute Max. Absolute Min.	Means.	Absolute Range.
66·77 66·67 64·14	65·55 66·97 65·60	68·13 67·47 66·74	63·80 65·92 63·95	66·59 66·63 64·51	71·17 70·46 67·64			
59·01 61·62 61·67	55·00 61·48 62·20	56·93 62·46 62·77	59·19 61·49 61·54	62·32 62·61 61·92	66·71 67·62 65·66			
58·33 50·25 49·04	58·61 48·47 48·18	59·25 49·31 48·84	57·69 46·29 46·19	60·15 48·82 48·30	62·55 48·34 47·89			
54·87 48·83 18·24	52·28 47·48 46·83	53·32 48·37 47·67	54·30 45·91 45·14	57·44 48·57 47·05	60·17 47·74 47·09			
62·55 58·46 56·59	62·08 57·72 56·89	63·69 58·39 57·79	60·74 56·10 55·07	63·37 57·72 56·40	66·86 59·10 57·76		68·07 62·18 60·87	
56·94 55·22 54·95	53·64 54·48 54·51	55·12 55·41 55·22	56·74 53·70 53·34	59·88 55·59 54·48	63·44 57·68 56·37		63·58 60·18 59·53	
87·50 83·50 72·00	80·00 80·50 81·50	81·00 79·25 77·50	83·00 77·50 76·00	89·00 87·00 86·00	89·00 88·00 86·50	104·50 (Jan.) 96·75 (Apr.) 94·50 (Apr.)		
68·50 75·75 79·00	66·50 70·00 76·00	63·00 73·25 75·00	70·50 75·00 74·50	77·00 79·25 82·00	90·50 85·75 85·00	95·50 (Feb.) 95·50 (Jan.) 94·00 (Jan.)		
46·00 41·75 41·00	41·50 36·75 33·50	46·00 41·50 41·50	38·50 38·25 37·00	51·00 40·50 40·00	42·00 41·25 41·00	41·50 (June) 36·75 (June) 33·50 (June)		
48·00 39·25 38·50	41·50 41·00 37·50	46·00 39·25 38·50	39·00 38·00 36·50	52·00 40·00 39·00	48·00 40·25 39·50	39·00 (Aug.) 38·00 (Aug.) 36·50 (Aug.)		
8·44 16·42 15·10	6·94 18·50 17·42	8·88 18·16 17·90	6·11 19·63 17·76	6·44 17·81 16·21	8·62 22·12 19·75			63·00 60·00 61·00
4·14 12·79 13·43	2·72 14·00 15·37	3·61 14·09 15·10	4·89 15·58 16·40	4·88 14·04 14·87	6·54 19·88 18·57			56·50 57·50 57·50

blowing





Table VIII.

AIR TEMPERATURES (THERMOMETERS IN STEVENSON'S SCREENS) UNDER FOREST CANOPY AND UNDER FULL EXPOSURE,  
DEEPWALLS.

Station.	Temperature °F.	Dec., 1924.		Jan., 1925.		Feb., 1925.		March, 1925.		April, 1925.		May, 1925.	
		Exposed.	Under Canopy.	Exposed.	Under Canopy.	Exposed.	Under Canopy.	Exposed.	Under Canopy.	Exposed.	Under Canopy.	Exposed.	Under Canopy.
<i>Deepwells.</i> 1,600 feet, 2 adjacent sites north aspect	Mean Max.....	80.93	71.35	80.12	69.19	86.51	73.85	80.27	70.00	75.26	63.78	75.00	61.90
	Mean Min.....	57.46	57.63	55.98	55.54	59.37	59.10	58.11	58.00	52.20	51.78	50.67	51.11
	Mean Temp.....	69.19	64.49	68.05	62.36	72.94	66.47	69.19	64.00	63.73	57.78	62.83	56.50
	Absolute Max.....	<i>105.50</i>	<i>89.00</i>	<i>91.00</i>	<i>78.50</i>	<i>110.00</i>	<i>92.00</i>	<i>98.00</i>	<i>78.00</i>	<i>105.00</i>	<i>82.50</i>	<i>103.50</i>	<i>74.00</i>
	Absolute Min.....	48.00	48.50	46.00	46.00	54.50	49.00	51.50	52.00	44.50	46.00	41.00	43.00
Station.	Temperature °F.	June, 1925.		July, 1925.		Aug., 1925.		Sep., 1925.		Oct., 1925.		Nov., 1925.	
		Exposed.	Under Canopy.	Exposed.	Under Canopy.	Exposed.	Under Canopy.	Exposed.	Under Canopy.	Exposed.	Under Canopy.	Exposed.	Under Canopy.
<i>Deepwells.</i> 1,600 feet, 2 adjacent sites north aspect	Mean Max.....	66.10	56.25	67.92	58.80	75.90	64.04	68.35	60.43	72.20	62.77	75.56	65.98
	Mean Min.....	46.51	47.66	48.76	48.43	48.32	48.83	49.30	49.46	48.77	49.01	51.28	51.46
	Mean Temp.....	56.30	52.10	58.34	53.61	62.11	56.43	58.82	54.94	60.48	55.89	63.42	58.72
	Absolute Max.....	<i>84.50</i>	<i>70.00</i>	<i>83.75</i>	<i>70.50</i>	<i>95.00</i>	<i>83.00</i>	<i>95.00</i>	<i>82.50</i>	<i>100.00</i>	<i>78.00</i>	<i>97.00</i>	<i>79.00</i>
	Absolute Min.....	38.50	41.50	37.00	38.00	38.50	39.50	39.00	41.50	37.00	37.50	43.50	44.00

Italic figures denote Bergwind blowing.

Table IX.

SUPERFICIAL SOIL TEMPERATURES (THERMOMETERS IN WOODEN TUBES, BULBS ENCASED IN PARAWAX). DEERWALLS.

Station	Temperature F.	Dec., 1924.		Jan., 1925.		Feb., 1925.		March, 1925.		April, 1925.		May, 1925.	
		1 p.m.	7 p.m.	1 p.m.	7 p.m.	1 p.m.	7 p.m.	1 p.m.	7 p.m.	1 p.m.	7 p.m.	1 p.m.	7 p.m.
North aspect, 1,600 feet fully exposed to insolation	Mean $\frac{1}{4}$ inch below surface	115.16	70.70	107.06	70.52	120.20	73.40	100.80	69.26	89.00	61.20	90.86	57.92
	Mean 6 inches below surface	68.50	70.75	68.29	71.37	71.77	74.77	69.00	71.25	63.09	65.55	60.39	62.04
Mean light intensity 6 inches above the soil = 1	Absolute Max. $\frac{1}{4}$ inch below surface	170.60	82.70	163.10	84.50	170.60	87.80	146.30	79.10	147.50	78.26	120.50	66.56
	Absolute Max. 6 inches below surface	73.25	77.50	72.75	76.00	77.75	80.50	74.50	79.00	72.25	75.75	63.25	66.25
North aspect, 1,600 feet under forest canopy	Mean $\frac{1}{4}$ inch below surface	69.21	61.80	64.87	62.66	67.73	65.44	65.87	63.65	60.80	58.10	59.11	56.09
	Mean 6 inches below surface	61.00	62.05	63.74	61.51	64.46	64.41	62.47	63.21	58.06	58.84	55.90	59.11
Mean light intensity 6 inches above the soil = 1,300	Absolute Max. $\frac{1}{4}$ inch below surface	79.75	76.50	74.00	70.25	77.50	73.50	72.00	71.00	76.25	70.00	67.50	62.25
	Mean Max. 6 inches surface	64.00	65.00	69.50	66.25	80.50	72.00	66.00	66.25	64.00	66.00	59.00	60.00

Italic figures denote Bergwind blowing.

Table IX.—(Continued.)  
SUPERFICIAL SOIL TEMPERATURES (THERMOMETERS IN WOODEN TUBES, BULBS ENCASED IN PARAWAX), DEEPWALLS.

Station.	Temperature °F.	June, 1925.		July, 1925.		Aug., 1925.		Sept., 1925.		Oct., 1925.		Nov., 1925.	
		1 p.m.	7 p.m.	1 p.m.	7 p.m.	1 p.m.	7 p.m.	1 p.m.	7 p.m.	1 p.m.	7 p.m.	1 p.m.	7 p.m.
North aspect, 1,600 feet fully exposed to insolation	Mean 4 inch below surface	75.38	50.72	81.70	55.04	93.92	57.74	89.96	57.20	96.44	50.00	108.50	65.48
	Mean 6 inches below surface	54.89	55.96	55.88	58.04	59.31	62.54	60.05	62.15	62.84	64.57	60.12	68.31
Mean light intensity 6 inches above the soil = 1	Absolute Max. 4 inch below surface	102.20	64.40	106.40	76.40	115.20	70.70	114.30	73.20	149.00	73.40	140.30	89.60
	Absolute Max. 6 inches below surface	59.75	62.00	61.50	62.25	66.30	70.00	69.00	73.30	68.00	71.25	72.75	74.50
North aspect, 1,600 feet under forest canopy	Mean 4 inch below surface	52.83	51.54	54.00	52.06	59.01	55.16	55.89	54.21	59.53	54.63	63.31	58.30
	Mean 6 inches below surface	51.93	52.75	53.27	54.07	54.58	55.82	54.50	55.28	54.96	56.19	56.75	58.07
Mean light intensity 6 inches above the soil = 1.300	Absolute Max. 4 inch below surface	61.50	60.00	61.00	61.00	72.25	64.75	72.75	68.00	76.00	64.25	80.00	66.00
	Absolute Max. 6 inches below surface	56.25	57.50	57.25	58.50	60.50	62.50	60.00	62.00	59.00	61.75	60.25	62.50

*Italic figures denote Bergwind blowing.*

Table X.  
SUPERFICIAL SOIL TEMPERATURE RUN FOR PORTION OF 30/1/25 AND 22/7/25, DEEPWALLS 1,600 FEET.

	6 in. Below Surface.		4 in. Below Surface.		Shade Max. 9 in. Above Surface.		Shade Min. 9 in. Above Surface.		Current Temp. 9 in. Above Soil.		Light.		Clouds.		Wind.	
	Exposed.	Under Canopy.	Exposed.	Under Canopy.	Exposed.	Under Canopy.	Exposed.	Under Canopy.	Exposed.	Under Canopy.	Exposed.	Under Canopy.	Exposed.	Under Canopy.	Exposed.	Under Canopy.
30 1/25																
1 Hour.																
7 a.m.	66.25	60.25	62.00	61.50	63.50	63.00	57.50	57.50	62.50	62.75	Sum.	Shade ranging from 1/200 to 1/300	0	0	0	0
9 a.m.	66.75	60.25	67.50	66.00	66.50	66.50	61.50	62.00	66.50	66.50	"	"	0	0	0	0
11 a.m.	67.50	60.75	100.80	68.75	81.00	72.50	66.00	66.00	81.00	72.25	"	"	0	0	0	0
1 p.m.	70.50	61.75	138.50	71.25	93.00	76.50	80.50	71.50	92.50	76.00	"	Where full light is 1	0	0	0	0
3 p.m.	71.50	62.75	143.60	72.75	95.50	78.00	92.50	75.50	94.50	77.75	"	"	0	0	0	0
5 p.m.	72.50	62.50	109.80	73.00	95.50	78.50	82.00	75.50	82.00	78.00	"	"	0	0	0	0
7 p.m.	74.50	64.25	83.70	70.25	83.00	79.00	74.00	72.00	74.25	72.50	"	"	0	2 N.W.	1 N.W.	
Means....	70.35	61.78	100.84	69.07	82.57	73.43	73.42	68.57	79.03	72.25						
22 7/25																
7 a.m.	53.75	52.50	43.70	49.25	55.00	54.00	47.00	48.00	48.00	49.00	Sum.	Shade ranging from 1/200 to 1/300	0	1 N.E.	0	0
9 a.m.	54.25	53.00	48.20	51.00	52.50	51.00	47.50	48.00	52.25	51.00	"	"	0	2 N.E.	1 N.E.	0
11 a.m.	54.50	53.25	55.80	54.00	59.00	56.50	52.00	50.50	59.00	56.25	"	"	0	0	0	0
1 p.m.	56.00	53.50	90.80	56.00	69.00	60.50	59.50	56.00	68.75	60.25	"	Where full exposure is 1	0	2 Berg	1 Berg	0
3 p.m.	59.75	54.00	93.20	57.75	73.00	62.50	68.50	59.50	68.00	64.50	Weak	"	5	2 "	1 "	0
5 p.m.	61.00	54.50	68.00	61.00	69.50	62.00	60.00	58.00	60.00	58.25	Dull	"	10	1 S.E.	0	0
7 p.m.	60.00	55.00	57.20	55.00	60.00	58.50	57.50	56.00	58.75	56.00	"	"	5	0	0	0
Means....	57.03	53.67	60.12	54.85	62.30	57.85	56.00	53.71	59.25	56.03						

Table XI.

DEEPER SOIL TEMPERATURES (THERMOMETERS IN STANDARD METAL TUBES; BULBS ENCASED IN PARAWAX). DEEPPWALLS.

Station.	Soil Temperature. ° F.	Year.	January.			February.			March.			April.			May.			June.		
			8.30 a.m.	1.30 p.m.	7.30 p.m.	8.30 a.m.	1.30 p.m.	7.30 p.m.	8.30 a.m.	1.30 p.m.	7.30 p.m.	8.30 a.m.	1.30 p.m.	7.30 p.m.	8.30 a.m.	1.30 p.m.	7.30 p.m.	8.30 a.m.	1.30 p.m.	7.30 p.m.
Exposed Site. Small (20 x 20 yds.). Exploited Site in Forest. South Aspect. 1,600 ft., Deepwalls.	1 ft. Below Surface	1923	61.10	—	62.13	61.53	—	62.55	61.39	—	61.90	57.35	—	58.02	52.70	—	53.11	50.99	—	51.36
		1924	64.54	66.02	65.83	63.25	64.36	64.25	59.84	60.97	60.02	57.11	58.13	58.05	52.14	52.72	52.73	49.65	50.10	50.43
		1925	63.08	65.16	65.22	65.00	66.70	66.75	63.46	64.31	64.45	57.86	58.46	58.02	53.88	54.29	54.41	50.49	51.01	51.49
		1923	60.02	—	60.16	60.84	—	60.74	60.93	—	60.93	58.36	—	58.04	54.42	—	54.45	52.55	—	52.54
Under (Climax Forest, 60-100 ft. High, with Dense Trichochadus, South Aspect. 1,600 ft. Deepwalls.	1 ft. Below Surface	1924	61.09	64.27	64.09	63.27	63.35	63.17	60.72	61.10	60.78	58.05	58.21	58.21	54.28	54.38	54.25	51.60	51.72	51.75
		1925	63.25	63.41	63.07	64.17	64.25	64.31	63.37	63.56	63.65	59.10	59.27	59.31	55.32	54.46	55.48	52.40	52.02	52.75
		1923	59.36	—	59.56	60.28	—	60.28	60.44	—	60.60	57.41	—	57.41	53.14	—	53.17	51.93	—	51.98
		1924	60.17	60.40	60.17	60.21	60.34	60.51	58.10	58.45	58.34	57.26	57.45	57.51	53.84	53.95	54.02	52.29	52.53	52.71
Under (Climax Forest, 60-100 ft. High, with Dense Trichochadus, South Aspect. 1,600 ft. Deepwalls.	2 ft. Below Surface	1925	59.49	59.56	59.83	61.38	61.61	61.87	61.25	61.38	61.60	57.83	58.09	58.25	55.45	55.66	55.78	52.08	52.20	52.79
		1923	58.75	—	58.82	59.59	—	59.59	59.91	—	59.86	58.11	—	58.11	54.43	—	54.55	53.09	—	53.21
		1924	59.40	59.61	59.40	59.63	59.87	59.63	58.53	58.82	59.70	57.46	57.60	57.64	55.34	55.52	55.39	53.79	53.92	54.00
		1925	58.95	59.08	59.12	60.26	60.41	60.55	60.83	60.92	60.94	58.60	58.80	58.85	56.47	56.65	56.61	53.85	53.97	54.24
Under (Climax Forest, 60-100 ft. High, with Dense Trichochadus, South Aspect. 1,600 ft. Deepwalls.	4 ft. Below Surface	1923	58.01	—	58.10	58.84	—	58.84	59.21	—	59.15	58.34	—	58.34	55.36	—	55.55	53.93	—	54.08
		1924	58.57	58.75	58.57	59.04	59.21	59.06	58.54	58.77	58.08	57.48	57.71	57.63	56.09	56.24	56.13	54.61	54.76	54.72
		1925	58.24	58.31	58.33	59.26	59.88	59.40	60.19	60.21	60.13	58.85	58.93	58.88	56.90	57.06	57.04	54.89	54.89	55.12

Table XI.—(Continued).

DEEPER SOIL TEMPERATURES (THERMOMETERS IN STANDARD METAL TUBES; BULBS ENCASED IN PARAWAX). DEEPWALLS.

Station.	Soil Temperature, F.	Year.	July.			August.			September.			October.			November.			December.		
			8.30 a.m.	1.30 p.m.	7 p.m.	8.30 a.m.	1.30 p.m.	7 p.m.	8.30 a.m.	1.30 p.m.	7 p.m.	8.30 a.m.	1.30 p.m.	7 p.m.	8.30 a.m.	1.30 p.m.	7 p.m.	8.30 a.m.	1.30 p.m.	7 p.m.
Exposed Soil 20 × 20 Yds., Exploited Site in Forest.	1 ft. Below Surface	1923	50.18	—	51.11	50.35	—	51.26	52.54	—	53.78	57.06	—	58.49	60.23	—	61.71	62.98	—	64.07
		1924	47.91	48.50	48.72	49.18	49.87	50.11	52.43	53.37	53.73	55.11	57.05	56.92	58.43	60.26	60.23	63.76	65.38	65.30
		1925	50.31	50.60	51.07	51.53	52.00	52.20	53.50	54.05	54.16	55.20	56.06	56.15	58.10	59.10	59.18	—	—	—
		1923	51.93	—	52.02	51.43	—	51.54	53.02	—	53.23	56.67	—	56.80	59.64	—	59.70	62.43	—	62.45
Aspen, 1,600 ft., Deepwells.	2 ft. Below Surface	1924	49.66	49.78	49.79	50.66	50.72	50.86	53.03	52.94	53.30	55.37	55.50	55.45	58.15	58.24	58.18	62.23	62.41	62.42
		1925	51.57	51.62	51.98	52.19	52.50	52.50	54.04	54.19	54.11	55.60	55.73	55.69	58.13	58.08	58.07	—	—	—
		1923	51.55	—	51.83	51.58	—	52.05	52.45	—	52.69	54.69	—	55.10	56.70	—	57.06	58.66	—	59.01
		1924	51.82	51.96	52.11	51.65	51.23	51.22	52.02	52.30	52.39	52.72	53.00	53.07	54.53	55.06	54.97	59.38	59.63	59.79
Dense Trophiculus, South Aspect, 1,600 ft., Deepwells.	2 ft. Below Surface	1925	52.30	52.46	52.72	53.08	53.32	53.49	53.38	53.56	53.76	53.69	53.81	54.13	55.65	55.87	56.12	—	—	—
		1923	52.55	—	52.82	52.27	—	52.50	52.95	—	53.06	54.45	—	54.63	56.22	—	56.38	57.98	—	57.97
		1924	52.93	53.10	53.19	52.24	52.45	52.43	52.62	52.73	52.83	53.11	53.29	53.25	54.48	54.69	54.62	58.08	58.30	58.15
		1925	53.47	53.56	53.70	53.60	53.81	53.89	53.88	54.05	54.02	54.09	54.21	54.24	55.50	55.70	55.71	—	—	—
4 ft. Below Surface	4 ft. Below Surface	1923	53.34	—	53.68	52.94	—	53.07	53.28	—	53.40	54.31	—	54.42	55.73	—	55.90	57.23	—	57.25
		1924	53.61	53.80	53.74	53.03	53.15	53.14	53.02	53.10	53.18	53.28	53.46	53.42	54.29	56.11	54.37	57.00	57.21	57.05
		1925	54.10	54.14	54.41	53.97	54.07	54.08	54.21	54.26	54.30	54.29	54.44	54.42	58.10	55.42	55.37	—	—	—

Table VII.

DEEPER SOIL TEMPERATURES (THERMOMETERS IN STANDARD METAL TUBES; BULBS ENCASED IN PARAWAX.)  
 EXAMPLES OF DIURNAL CHANGES UNDER FULL EXPOSURE AND UNDER FOREST CANOPY, FOR A TYPICAL WINTER DAY  
 AND A TYPICAL SUMMER DAY: DEEPWALLS.

Hour.	Soil Temperature 12 in. Below Surface.				Soil Temperature 24 in. Below Surface.				Soil Temperature 48 in. Below Surface.	
	12th July, 1923.		10th January, 1924.		12th July, 1923.		10th January, 1924.		12th July, 1923.	10th January, 1924.
	Exposed.	Under Canopy.	Exposed.	Under Canopy.	Exposed.	Under Canopy.	Exposed.	Under Canopy.	Under Canopy.	Under Canopy.
8 a.m.	50.00	51.10	63.00	59.50	52.00	53.00	62.25	59.00	53.75	58.50
9 a.m.	50.00	51.10	63.10	59.50	52.00	53.00	63.50	59.00	53.75	58.50
10 a.m.	50.10	51.10	63.75	59.75	52.00	53.00	63.60	59.10	53.60	58.60
11 a.m.	50.10	51.10	64.25	59.75	52.00	52.90	63.60	59.25	53.50	58.75
12 a.m.	50.10	51.10	64.75	59.75	52.00	52.90	63.75	59.25	53.50	58.75
1 a.m.	50.25	51.10	65.10	59.75	52.00	52.90	63.75	59.25	53.50	58.75
2 a.m.	50.25	51.10	66.00	59.75	52.00	52.75	63.75	59.30	53.50	58.75
3 a.m.	50.25	51.10	66.00	59.90	52.00	52.75	63.75	59.25	53.50	58.75
4 a.m.	50.25	51.10	66.00	59.90	52.00	52.75	63.75	59.25	53.50	58.75
5 a.m.	50.25	51.10	66.00	60.00	52.00	52.90	63.50	59.25	53.50	58.75
6 a.m.	50.25	51.10	65.75	60.00	52.00	53.00	63.25	59.00	53.50	58.25
Means	50.17	51.10	64.97	59.79	52.00	52.88	63.57	59.19	53.57	58.65
8 p.m.	50.25	51.25	65.50	60.00	52.00	53.00	63.25	59.00	53.75	58.25
9 p.m.	50.25	51.25	65.50	60.00	52.00	53.00	63.25	59.00	54.00	58.25
10 p.m.	50.25	51.25	65.50	60.25	52.00	53.00	63.50	59.25	54.00	58.50
11 p.m.	50.25	51.50	65.50	60.25	52.00	53.00	63.50	59.25	53.75	58.50
12 p.m.	50.25	51.50	65.25	60.25	52.00	53.00	63.75	59.25	53.75	58.75
1 a.m.	50.25	51.50	65.10	60.25	52.00	53.00	63.75	59.25	53.75	58.75
2 a.m.	50.10	51.50	65.00	60.25	52.00	52.75	63.75	59.25	53.50	58.75
3 a.m.	50.10	51.50	64.75	60.25	52.00	52.75	63.75	59.25	53.50	58.75
4 a.m.	50.10	51.50	64.75	60.25	52.00	52.75	63.75	59.25	53.50	58.75
5 a.m.	50.25	51.50	64.75	60.25	52.00	52.90	63.75	59.25	53.50	58.75
6 a.m.	50.25	51.50	64.25	60.25	52.00	52.90	63.75	59.25	53.50	58.75
Means	50.21	51.43	64.97	60.18	52.00	52.90	63.62	59.19	53.66	58.62

Table XIII.

AVERAGE POSSIBLE NUMBER OF HOURS DIRECT SUNLIGHT, BY WEEKS :  
DEEPWALLS.

Date.	Hours.	Date.	Hours.	Date.	Hours.
January 1.....	14·20	May 6.....	10·32	September 2....	11·25
8.....	14·14	13.....	10·22	9....	11·40
15.....	14·07	20.....	10·13	16....	11·54
22.....	13·58	27.....	10·04	23....	12·09
29.....	13·47			30....	12·23
		Means.....	10·18		
Means.....	14·05			Means.....	11·54
February 5.....	13·34	June 3.....	9·58	October 7.....	12·37
12.....	13·21	10.....	9·54	14.....	12·52
19.....	13·07	17.....	9·51	21.....	13·06
26.....	12·53	24.....	9·51	28.....	13·20
Means.....	13·13	Means.....	9·53	Means.....	12·58
March 4.....	12·38	July 1.....	9·55	November 4....	13·13
11.....	13·23	8.....	9·59	11....	13·46
18.....	12·08	15.....	10·05	18....	13·57
25.....	11·53	22.....	10·12	25....	14·07
		29.....	10·22		
Means.....	12·15			Means.....	13·50
		Means.....	10·06		
April 1.....	11·39	August 7.....	10·33	December 2....	14·14
8.....	11·25	12.....	10·45	9....	14·18
15.....	11·11	19.....	10·58	16....	14·21
22.....	10·58	26.....	11·11	23....	14·22
29.....	10·44			30....	14·20
		Means.....	10·51		
Means.....	11·11			Means.....	14·19



Table XIV (a).

## HOURS OF DIRECT SUNLIGHT, DEEPWALLS, TOTAL PER MENSEM.

Year.	Jan.	Feb.	Mar.	Apl.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.	Average.
1923.....	250	198	220	160	212	217	184	249	230	195	217	271	2,603	216.9
1924.....	246	248	229	252	198	189	208	216	137	225	245	277	2,670	222.5
1925.....	264	262	174	207	214	163	194	215	148	211	261	231	2,544	212.0

Table XIV (b).

## AVERAGE PER DIEM.

Year.	Jan.	Feb.	Mar.	Apl.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	
1923.....	8.0	7.0	7.1	5.3	6.8	7.2	5.9	8.0	7.6	6.2	7.2	8.7	
1924.....	7.9	8.5	7.3	8.4	6.3	6.3	8.3	6.9	4.5	7.2	8.1	8.9	
1925.....	8.5	9.3	5.6	6.9	6.9	5.4	6.2	6.9	4.9	6.8	8.7	8.5	
Average: Actual..	m. 8.6	m. 8.12	m. 6.30	m. 6.48	m. 6.36	m. 6.18	m. 6.48	m. 7.12	m. 5.36	m. 6.42	m. 8.0	m. 8.42	h. m. = 7.8
„ Possible	14.05	13.13	12.15	11.11	10.18	9.53	10.06	10.51	11.54	12.58	13.50	14.19	h. m. = 12.4

Table XV.

## COMPARISON OF DURATION OF DIRECT SUNLIGHT FOR SEVERAL CENTRES.

Centre.	Percentage of Total Possible Hours per Year.	Average Number of Hours of Sun- shine per Diem.
Kimberley.....	78	9.41
Johannesburg.....	73	8.70
Capetown.....	66	7.51
Kuysna (Deepwalls).....	59	7.13
Baltimore.....	58	7.10
London.....	29	3.80

Table XVI.

## RATIO OF DIRECT : DIFFUSED LIGHT.

Station.	Date.	Hour.	Ratio.		
			Intensity : Total.	Intensity : Direct.	Intensity : Diffused.
Deepwells.....	21 12 23	Noon	5	4	1
	21 3 24	"	5	4	1
	21 6 24	"	5	4	1

Table XVII (a).

CONDITION OF THE SKY : DEEPWALLS 1,725 FEET (0 = CLOUDLESS SKY ;  
10 = ENTIRELY CLOUDED SKY).

	June, 1925.	July, 1925.	Aug., 1925.	Sept., 1925.	Oct., 1925.	Nov., 1925.	Dec., 1925.	Jan., 1926.	Feb., 1926.	Mar., 1926.	Apl., 1926.	May., 1926.	For the Year (Approx.)
8 a.m.	6	5	4	7	5	5	5	4	5	4	5	6	5.0
1 p.m.	4	4	3	5	5	5	5	5	5	5	4	5	5.0
7 p.m.	4	7	4	7	7	6	6	6	6	6	5	5	6.0

Table XVII (b).

COMPARISON OF DEGREE OF CLOUDINESS FOR SEVERAL CENTRES IN CAPE  
PROVINCE AND NATAL.

Centre.	Latitude S.	Longitude E.	Degree of Cloudiness.
*Wellington.....	33 58'	19 0'	3.8
*Mossel Bay.....	34 11'	22 9'	4.2
Deepwells.....	33 55'	23 10'	5.3
*Kingwilliamstown.....	32 51'	27 22'	4.1
*Coastbelt, Natal.....	30 (Approx.)	31 (Approx.)	4.7

\* Dreyer (1888, 55).

† Bews, J. W. (1920, 374).

## EXAMPLES OF PHOTOMETRIC READINGS TAKEN IN THE FORESTS PER CLEMENTS'S STOPWATCH PHOTOMETER.

Date.	Time.	Condition of the Sky (6°; Cloudless).	Position of the Photometer	Characteristics of the Locality.	Value Compared with the Standard.	Standard.
22/1/24	9 a.m. 12 noon 3 p.m.	0	6 inches from soil, under the dense <i>Trichodadus</i>	High Forest with <i>Podocarpus Thunbergii</i> and <i>Olea laurifolia</i> dominant; dense stocking of smaller trees and of the layer societies of <i>Trichodadus retusus</i> . Northern aspect; slope 10°; elevation 1,600 feet	1.300 1.500 1.250	Standard timb., noon. 21 1/24.
22/1/24	9 a.m. 12 noon 3 p.m.	0	20 feet above the soil, among the crowns of the trees (ladder erected)	High Forest with <i>Podocarpus Thunbergii</i> and <i>Olea laurifolia</i> dominant; dense stocking of smaller trees and of the layer societies of <i>Trichodadus retusus</i> . Northern aspect; slope 10°; elevation 1,600 feet.	1.100 1.125 1.50	Standard timb., noon 21 1/24.
22/1/24	9 a.m. 12 noon 3 p.m.	0	40 feet above the soil, among the crowns of the taller trees (ladder erected)	High Forest with <i>Podocarpus Thunbergii</i> and <i>Olea laurifolia</i> dominant; dense stocking of smaller trees and of the layer societies of <i>Trichodadus retusus</i> . Northern aspect; slope 10°; elevation 1,600 feet	1.50 1.25 2.25	Standard timb., noon. 21 1/24.
9/10/25	3 p.m.	0	12 inches from soil	High Forest with <i>Podocarpus</i> spp., <i>Olea laurifolia</i> dominant, and with dense layer-society of <i>Heulandia capensis</i> 8 to 12 feet in height. Southern aspect; slope 5°, elevation 1,500 feet	1.1000	Full exposure, 2.45 p.m., 9/10/25.
6/11/25	12.10 p.m.	0	5 feet from soil	<i>Utrigia capensis</i> consociates 25 to 30 feet high, with scattered shrubs to 7 feet, and dense, small-stage natural regeneration of <i>Mursine melanophloeos</i> . Aspect flat; elevation 700 feet	1.5	Full exposure, 12 noon, 6/11/25.
6/11/25	12.15 p.m.	0	5 feet from soil	Small exploited site (focus-spot) in the Forest. 20 by 20 yards. Aspect flat; elevation 700 feet.	3.4	Full exposure, 12 noon, 6/11/25.
7/2/25	11.45 a.m.	0	6 inches from soil	Dense consociates of 5 year old <i>Utrigia patella</i> , 8 to 10 feet high. Elevation 1,500 feet; aspect flat	1.300	Full exposure, 12 noon, 7/2/25.
29/7/25	12.5 p.m.	0	12 inches from soil	Tall <i>Macchia</i> ( <i>Baccharis intermedia</i> , <i>Erica canaliculata</i> , <i>E. spectiosa</i> , <i>Myrtadula</i> , <i>Polypodium nigrifolium</i> , etc.), 10 to 15 feet high. Aspect flat; elevation 700 feet	1.300	Full exposure, 12 noon, 29/7/25.
29/7/25	12.15 p.m.	0	12 inches from soil	Tall <i>Macchia</i> : <i>Baccharis intermedia</i> consociates.	1.420	Full exposure, 12 noon, 29/7/25.
17/2/26	2.30 p.m.	0	(1) Immediately above the <i>Pteranthus</i> (2) on soil under the <i>Pteranthus</i>	Luxuriant <i>Pteranthus frutescens</i> consociates on a clear-felled site in Forest, Harkerville; 1½ years after felling	(1) 1 (2) 1.360	Full exposure, 2 p.m., 17/2/26.
17/2/26	2/15 p.m.	0	(1) Immediately above the <i>Helichrysum</i> (2) on soil under the <i>Helichrysum</i>	Luxuriant <i>Helichrysum petaloatum</i> consociates on a clear-felled site in Forest, Harkerville; 1½ years after felling	(1) 1 (2) 1.360	Full exposure, 2 p.m., 17/2/26.
17/2/26	2.5 p.m.	0	(1) Immediately above the <i>Aspidium</i> (2) on soil under the <i>Aspidium</i>	Heavily exploited Forest, Harkerville, 1½ years after felling. Under open canopy of <i>Podocarpus</i> , <i>Olea</i> , <i>Apodaxis</i> , <i>Droba</i> . On ground dense layers of <i>Aspidium capense</i> 3 to 5 feet high	(1) 4/5 (2) 1.180	Full exposure, 2 p.m., 17/2/26.

## NOTE TO TABLES XIX, XX, AND XX(a).

*Vapour Pressure.*

The pressure in millibars of the aqueous vapour *actually* in the air.

*Saturation Deficit.*

The *lack* of vapour pressure, that is, the difference between the *actual* vapour pressure and that amount which the air would contain at the current temperature were the space saturated with aqueous vapour. It is the difference between the vapour pressure for the current temperature (dry bulb) and the vapour pressure for the temperature of the current dew-point. Without reference to temperature, the saturation deficit gives a measure of the dryness of the air. It is a distinctly more useful means of expression than is the relative humidity concept.

*Relative Humidity.*

The ratio, expressed as a percentage, of the *actual* aqueous vapour and that which would be present were the space saturated at the current temperature of the air.

*Millibar.*

The *millibar* is the 1/1000th part of a *bar* (the meteorological unit of atmospheric pressure in the C.G.S. system), and is equivalent to 1,000 dynes per square metre, or to the pressure of 0.0295306 inches of mercury at 32° F., in lat. 45. The *millibar* has been in use in the British Meteorological Office since 1st May, 1914.

Table XIX.

VAPOUR PRESSURE,\* SATURATION DEFICIT† AND RELATIVE HUMIDITY‡ DATA (FROM 8.30 A.M. READINGS OF DRY AND WET BULB THERMOMETERS IN STEVENSON'S SCREENS 4 FEET ABOVE GROUND).

Station and Remarks.	Humidity.	Year.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual Mean.
Deepwells (1,725 ft.), De Vugt Plateau	Mean Vapour Pressure (Millibars)	1923	—	16.4	15.4	11.6	8.9	8.3	7.5	8.0	10.5	12.4	14.2	15.4	11.6
		1924	15.9	15.7	13.8	12.6	8.9	8.0	7.2	8.2	10.6	10.9	13.0	16.5	11.7
		1925	16.0	18.1	17.6	12.0	9.9	8.2	8.6	9.6	10.9	11.9	12.9	14.7	12.5
	Mean Saturation Deficit (Millibars)	1923	—	4.0	4.7	5.9	5.5	5.2	4.2	6.6	4.5	5.0	4.1	4.8	4.9
		1924	5.5	5.3	4.0	6.0	5.5	6.3	6.9	4.5	3.5	5.0	3.5	6.0	5.1
		1925	4.6	7.3	3.7	6.1	6.0	4.6	4.5	6.7	3.7	4.0	5.3	5.0	5.1
	Mean Relative Humidity (Percentage)	1923	—	85.1	77.6	74.3	64.0	66.5	68.1	59.3	78.6	76.1	79.0	79.0	73.4
		1924	72.0	79.0	80.5	74.4	65.9	62.7	57.2	70.0	80.0	71.1	75.9	76.7	72.1
		1925	78.7	78.0	85.9	72.2	67.1	68.7	70.6	63.3	81.6	77.2	72.3	76.6	74.3
	Mean Temperature of the Dry Bulb, at 8.30 a.m., °F.	1923	—	63.45	63.42	58.83	54.29	52.09	51.53	54.60	53.37	58.85	60.83	63.09	57.66
		1924	65.70	64.60	59.50	60.60	54.08	53.47	53.38	51.30	52.96	56.60	57.92	66.39	58.04
		1925	64.29	68.16	64.77	59.94	56.70	51.15	51.39	56.41	54.10	56.72	60.49	62.70	58.90
Belvidere (Sealevel), on Estuary of the Kynsna River	Mean Vapour Pressure (Millibars)	1923	18.0	19.2	18.2	14.8	11.6	10.8	10.8	10.5	12.9	15.3	16.5	18.1	14.7
		1924	18.7	18.2	15.6	14.9	11.6	10.6	9.9	11.2	13.4	14.0	15.8	19.8	14.4
		1925	18.6	20.4	19.0	14.8	12.1	10.3	10.8	12.4	13.2	14.1	15.2	16.8	14.8
	Mean Saturation Deficit (Millibars)	1923	6.3	5.2	4.7	3.4	2.8	1.8	1.9	2.4	2.7	4.8	6.5	6.6	4.0
		1924	6.4	5.9	3.4	3.7	1.6	2.4	1.7	1.6	2.0	4.1	4.5	5.5	3.5
		1925	6.0	5.6	3.5	2.7	2.1	2.3	1.9	1.4	3.7	4.7	6.9	5.8	3.8
	Mean Relative Humidity (Percentage)	1923	75.7	78.7	79.9	82.5	82.8	88.2	85.6	84.4	83.0	77.9	72.1	74.1	80.4
		1924	74.3	76.0	82.3	83.7	88.5	84.1	86.5	87.6	87.0	74.4	77.7	76.8	81.5
		1925	75.8	79.5	86.1	84.9	85.7	84.3	85.8	89.5	80.5	75.6	68.7	75.0	80.9
	Mean Temperature of the Dry Bulb, at 8.30 a.m., °F.	1923	68.90	69.30	67.50	60.69	54.20	51.00	50.30	51.00	56.78	63.56	67.70	69.63	60.88
		1924	70.60	69.00	62.26	60.96	52.10	51.00	48.26	50.64	56.10	60.08	63.94	70.85	59.61
		1925	69.40	71.00	66.70	59.20	54.00	50.73	50.90	53.15	58.56	61.48	66.52	67.13	60.73

\*, †, ‡, cite these terms in Note to Tables XIX, XX, and XX (a). p. 74

Table XX. (Continued).

Station and Remarks.		Year.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual Mean.
Kadiköy (1,180 ft.), Uplands Plateau		1924	17.2	16.0	11.2	12.1	9.5	8.6	8.9	9.3	12.0	11.1	13.1	17.0	12.4
Mean Vapour Pressure (Millibars)															
Mean Saturation Deficit (Millibars)		1924	5.6	5.0	4.6	7.8	6.5	6.5	7.7	5.0	2.6	4.7	4.9	5.8	5.5
Mean Relative Humidity (Percentage)		1924	77.5	78.1	77.5	69.8	63.3	62.1	57.6	70.0	82.0	70.6	73.0	78.0	71.6
Mean Temperature of the Dry Bulb at 8.30 a.m.		1924	66.90	61.90	61.30	62.30	56.80	54.80	57.80	53.70	54.70	57.30	60.60	66.60	59.80
Bachköy (650 ft.), Uplands Plateau		1925	—	—	—	—	—	—	—	—	—	14.0	13.0	15.4	14.4
Mean Vapour Pressure (Millibars)		1926	18.2	17.2	17.0	15.6	13.2	11.5	10.7	10.0	11.2	—	—	—	13.8
Mean Saturation Deficit (Millibars)		1925	—	—	—	—	—	—	—	—	—	3.2	5.5	5.1	4.6
Mean Relative Humidity (Percentage)		1926	6.0	4.9	3.1	2.5	2.9	3.5	2.1	2.7	3.8	—	—	—	3.5
Mean Temperature of the Dry Bulb, at 8.30 a.m.		1925	—	—	—	—	—	—	—	—	—	81.5	72.0	75.9	76.4
		1926	75.8	78.6	84.1	86.4	82.3	81.3	84.7	82.5	79.1	—	—	—	81.6
		1925	—	—	—	—	—	—	—	—	—	58.6	62.5	64.3	61.8
		1926	69.0	66.4	64.2	61.0	56.6	55.1	50.7	52.4	55.2	—	—	—	58.9

\*, †, ‡, cide these terms in Note to Tables XIX, XX, and XXa. p. 74.

Table XX.

VAPOUR PRESSURE, SATURATION DEFICIT, AND RELATIVE HUMIDITY DATA (FROM 1 P.M. READINGS OF DRY AND WET BULB THERMOMETERS IN STEVENSON'S SCREENS 4 FEET ABOVE GROUND) ON TWO ADJACENT SITES: THE ONE FULLY EXPOSED TO INSOLATION THROUGH REMOVAL OF THE FOREST CANOPY, THE OTHER UNDER FOREST CANOPY.

Station.	Humidity.	December, 1924.		January, 1925.		February, 1925.		March, 1925.		April, 1925.		May, 1925.		June, 1925.	
		Ex-posed.	Under Canopy.	Ex-posed.	Under Canopy.	Ex-posed.	Under Canopy.	Ex-posed.	Under Canopy.	Ex-posed.	Under Canopy.	Ex-posed.	Under Canopy.	Ex-posed.	Under Canopy.
Deepwalls (1,600 ft.), Aspect North	Mean Vapour Pressure (Millibars)	19.4	19.6	19.7	18.1	21.3	21.4	20.5	20.0	16.4	15.6	14.6	13.6	12.2	11.6
	Mean Saturation Deficit (Millibars)	14.4	3.6	10.9	4.1	18.9	5.6	11.3	2.9	11.5	4.0	15.0	4.9	7.0	3.4
	Mean Relative Humidity (Percentage)	65.4	81.3	69.3	82.5	60.2	80.0	71.4	88.8	69.0	83.4	59.7	76.2	68.3	81.7
	Mean Temperature of the Dry Bulb, at 1 p.m. °F.	77.19	68.46	74.73	66.58	82.42	71.54	75.42	67.07	70.56	62.30	71.40	60.91	61.60	54.79

Table XV.—(Continued.)

Station.	Humidity	July, 1925.		August, 1925.		September, 1925.		October, 1925.		November, 1925.		Annual Mean.	
		Ex-posed.	Under Canopy.	Ex-posed.	Under Canopy.	Ex-posed.	Under Canopy.	Ex-posed.	Under Canopy.	Ex-posed.	Under Canopy.	Ex-posed.	Under Canopy.
Deepwells (1,600 ft.), Aspect North	Mean Vapour Pressure (Millibars)	12.3	11.7	14.5	13.5	13.8	13.1	15.5	14.0	16.1	15.2	16.3	15.5
	Mean Saturation Deficit (Millibars)	9.1	5.1	12.3	5.3	8.2	3.7	9.0	3.7	13.1	5.3	11.5	4.3
	Mean Relative Humidity (Percentage)	62.1	71.7	62.0	75.6	71.3	83.5	68.8	81.6	61.8	76.2	65.5	80.2
	Mean Temperature of the Dry Bulb at 1 p.m., °F.	64.33	56.86	70.11	61.08	64.63	57.96	67.54	59.64	73.21	63.84	71.9	62.58



OCCURRENCES OF RELATIVE HUMIDITIES LOWER THAN 40 PER CENT. FOR THE STATIONS DEALT WITH IN TABLES XIX AND XX.  
RELATIVE HUMIDITIES OCCURRING ON DAYS OF "BERGWINDS" BEING IN ITALIC FIGURES.

Station.	Year.	Hour.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Deerwalls (1,725 ft.)	1923	8.30 a.m.	—	38	31.5, 32	18, 13, 24	33, 38, 39, 34, 38, 30.5, 20.5	39, 25.5, 23, 32, 32.5	28.5, 20, 30, 27.5, 33.5	36, 22.5, 19, 13, 37, 13, 28, 36, 37, 14	19, 15, 26.5	32.5, 15, 17.5	—	—	39
	1924	—	—	38, 37	38, 30.5	34, 38, 25, 26	27.5, 30, 23, 33, 32.5, 37	37, 26, 26.5, 19.2, 37, 17, 25, 29, 20	23, 21, 11, 30, 25, 19, 18, 17, 28.5, 37.7	32, 16, 30, 28	18.5, 23, 36.5	38.5, 31	—	38.5, 39	44
—	1925	—	—	37, 25	—	36.5, 31.5, 27	34.5, 32.5, 31, 38, 33	17.5, 36.5, 38.5, 29, 28.5	39, 33, 25, 34.5	27, 37, 31, 20.5, 34, 34, 22, 38, 15, 27	25.5, 30.5, 28	—	—	—	32
Totals	—	—	0	5	4	10	18	19	19	24	9	5	0	2	115
Bolvidere	1923	8.30 a.m.	—	—	—	—	39.5	27.5	31.5	—	—	—	—	—	1
	1924	—	—	—	—	32.5	27.0	—	—	—	—	—	—	—	3
—	1925	—	—	—	—	—	—	—	—	—	—	—	—	—	2
Totals	—	—	—	—	—	1	2	1	1	—	1	—	—	—	6
Kathirkop	1924	8.30 a.m.	38.5	34	36.5, 38	27.5, 16, 21, 16.5	31.5, 26, 38.5, 23.5, 33, 21	26.5, 30, 15.5, 15, 25, 26.2, 26, 20	21.5, 25.5, 35.5, 25, 25, 25.5, 14.5, 15, 30.7	16, 22	33.5	37, 34	—	—	36
	Totals	—	1	1	2	4	7	7	9	2	1	2	0	0	36
Harkerville	1925	30 a.m.	—	—	—	—	—	—	—	—	—	—	—	—	1
	1926	—	20	—	—	—	—	32	38	25, 25.5	31, 20.5	32.0	—	—	7
Totals	—	—	1	—	—	—	—	1	1	2	2	1	—	—	8

Table XX (a).—(Continued.)

Station.	Year.	Hour.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
			Exposed.	Under Canopy.	Exposed.	Under Canopy.	Exposed.	Under Canopy.	Exposed.	Under Canopy.	Exposed.	Under Canopy.	Exposed.	Under Canopy.	Exposed.
Dorpwall, North Asper (1,600 ft.)*	1924	1 p.m.	—	—	—	—	—	—	—	—	—	—	—	—	—
			—	—	—	—	—	—	—	—	—	—	—	—	—
			—	—	—	—	—	—	—	—	—	—	—	—	—
			—	—	—	—	—	—	—	—	—	—	—	—	—
	1925	1 p.m.	—	—	—	—	—	—	—	—	—	—	—	—	—
			—	—	—	—	—	—	—	—	—	—	—	—	—
			—	—	—	—	—	—	—	—	—	—	—	—	—
			—	—	—	—	—	—	—	—	—	—	—	—	—
Totals			—	—	—	—	—	—	—	—	—	—	—	—	—
			—	—	—	—	—	—	—	—	—	—	—	—	—
			—	—	—	—	—	—	—	—	—	—	—	—	—
			—	—	—	—	—	—	—	—	—	—	—	—	—

\* Period: 1st December, 1924–30th November, 1925, only.

Table XXI.

COMPARISON OF RAINFALL MEANS FOR 15 CENTRES IN OR NEAR THE REGION.

Stations.	Long. E.	Lat. S.	Period.	Rainfall in Inches.	Number of Days.	Percentage of	
						Summer Rainfall.	Winter Rainfall.
Mossel Bay.....	22-09	34-11	1877-1915	17-31	90	47	53
George.....	22-29	33-57	1878-1915	31-36	125	57	43
Millwood.....	22-59	33-53	1887-1915	41-64	120	58	42
Buffelsnek.....	23-10	33-53	1890-1915	17-69	124	55	45
Sourflats.....	23-00	33-57	1888-1915	31-68	115	56	44
Knysna.....	23-03	34-03	1880-1915	8-27	97	49	51
Concordia.....	23-03	34-02	1891-1915	37-96	113	54	46
Harkerville.....	23-12	34-03	1888-1915	37-92	115	51	49
Plettenberg Bay.....	23-22	34-04	1891-1915	26-33	77	47	53
Forest Hall.....	23-31	33-59	1890-1902	29-25	108	56	44
Lottering.....	23-41	33-56	1896-1915	12-35	105	54	46
Storms River.....	23-52	33-58	1883-1915	44-40	128	53	4
Wit Els Bosch.....	24-09	34-00	1892-1915	44-99	106	52	48
Humansdorp.....	24-46	34-02	1878-1915	26-88	92	50	50
Uniondale.....	23-09	33-29	1878-1915	13-50	49	45	55

Table XXII.

## MONTHLY RAINFALL DATA FOR FIVE STATIONS WITHIN THE KNYSSNA REGION.

Altitude and Position.	Station.	Rainfall.	Year.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
10 ft., on Banks of Estuary, Knyssna, 2 Miles from Sea (Air Line)	Belvidere Lat. 33° 04' S. Long. 18° 23' 00" E.	Total in Inches	1923	3.92	1.38	2.03	1.77	2.57	3.72	1.35	2.96	1.92	2.47	3.36	1.54	32.29
			1924	2.47	1.35	1.69	2.21	2.62	2.53	1.06	1.56	3.13	2.86	3.42	1.47	29.97
			1925	2.24	1.23	1.76	1.62	1.03	3.84	1.01	2.17	8.15	3.45	2.76	3.59	32.85
		Number of Days with Rainfall 0.01 Inch and over	1923	16	9	11	14	11	11	10	9	9	8	13	8	129
			1924	17	5	11	8	9	13	9	16	12	10	14	13	127
			1925	12	8	13	11	8	14	12	12	15	12	10	14	141
		Greatest Amount in 24 Hours	1923	1.57	0.34	1.03	1.02	1.26	1.44	0.51	1.19	1.06	1.45	1.57	0.37	—
			1924	1.15	0.71	0.70	0.88	1.19	0.36	0.31	1.57	1.56	1.23	0.95	0.44	—
			1925	0.65	0.64	0.46	0.45	0.24	1.59	0.30	1.12	3.60	1.03	0.69	0.86	—
1,150 ft., on Upper Portion of T. plands or 1st Plateau, on edge of Main Forest, 5 1/2 Miles from Sea (Air Line)	Kaffirkop	Total in Inches	1923	3.27	1.61	2.10	4.34	3.28	2.44	1.00	2.86	2.45	3.88	3.97	1.74	32.94
			1924	2.35	1.54	2.42	2.21	2.19	3.22	0.62	4.44	3.81	2.27	3.13	1.95	30.15
			1925	1.91	2.81	2.42	2.86	1.58	3.58	1.58	2.70	6.59	5.16	3.21	3.35	37.78
		Number of Days with Rainfall 0.01 Inch and over	1923	16	9	11	13	10	8	3	7	7	5	13	7	109
			1924	7	5	10	5	10	10	6	9	12	8	9	12	103
			1925	8	8	7	10	6	10	5	9	15	11	8	10	107
		Greatest Amount in 24 Hours	1923	0.91	0.31	1.35	0.91	1.35	1.02	0.56	1.35	0.91	1.65	1.65	0.53	—
			1924	1.05	0.65	0.51	0.89	0.79	1.01	0.22	1.32	1.23	1.03	1.00	0.60	—
			1925	0.49	1.35	0.40	1.21	0.60	1.60	0.64	1.20	2.51	1.72	1.00	0.60	—

Table XXII.—(Continued).

## MONTHLY RAINFALL DATA FOR FIVE STATIONS WITHIN THE KINYSA REGION.

Altitude and Position.	Station.	Rainfall.	Year.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1,725 ft., 9 Miles from Sea (Air Line), Plateau in Main Forest.	Deepwells Lat. : 33-90 S. Long. : 23-16 E. (Approx.)	Total in Inches	1923	5-77	2-71	2-76	5-12	3-64	2-91	1-24	2-93	3-05	4-11	5-65	3-51	43-40
			1924	3-64	3-57	3-02	2-91	2-96	2-41	0-61	5-76	5-90	4-77	4-38	4-27	41-20
			1925	3-17	2-83	4-11	3-83	1-95	3-96	2-66	3-59	9-04	6-03	3-91	4-88	49-96
		Number of Days with Rainfall 0-01 inch and over	1923	18	13	15	17	10	11	9	8	11	13	16	11	152
			1924	11	8	14	12	10	10	7	12	16	13	16	15	144
			1925	12	10	15	12	8	10	7	8	16	14	11	18	141
1,500 ft., 12 Miles from Sea (Air Line)	Millwood Lat. : 33-53 S. Long. : 22-59 E.	Greatest Amount in 24 Hours	1923	2-07	0-88	1-32	0-96	1-65	1-20	0-45	0-88	1-05	1-62	1-93	0-95	—
			1924	1-13	1-14	1-18	0-76	1-05	0-61	0-25	1-58	2-35	1-38	1-18	1-01	—
			1925	0-74	1-00	1-31	1-04	0-97	1-68	1-75	1-72	3-40	1-69	1-28	1-02	—
		Total in Inches	1923	5-01	2-64	2-98	5-24	2-31	2-31	0-75	2-70	1-96	3-61	5-67	2-71	37-89
			1924	3-79	2-96	1-95	3-41	2-79	2-38	0-58	4-77	5-27	2-89	4-96	5-82	41-57
			1925	3-31	2-14	4-11	3-51	2-38	3-07	1-12	4-40	10-95	4-39	3-30	4-13	46-81
		Number of Days with Rainfall 0-01 inch and over	1923	14	10	12	16	8	7	5	9	10	9	11	13	123
			1924	8	7	9	10	10	8	5	13	12	11	14	12	119
			1925	11	9	15	12	9	13	8	8	18	15	10	17	145
		Greatest Amount in 24 Hours	1923	1-30	0-56	1-32	0-95	2-50	1-00	0-36	0-86	0-79	1-40	2-03	0-60	—
			1924	1-61	1-07	0-76	0-85	1-30	0-51	0-19	1-20	2-70	0-70	0-95	1-22	—
			1925	0-91	0-88	1-40	1-03	0-97	1-49	0-67	1-77	4-86	1-30	1-03	0-68	—

Table XXVII.—(Continued).

## MONTHLY RAINFALL DATA FOR FIVE STATIONS WITHIN THE KNYNSA REGION.

Altitude and Position.	Station.	Rainfall.	Year.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
580 ft., 3 Miles from Sea (Air Line), on the Plateau below the Mountains	Stornes River Lat. : 33° 58' S. Long. : 23° 52' E.	Total in Inches	1923	5.71	2.00	1.92	3.99	3.08	4.56	1.66	1.81	2.36	2.93	3.41	3.10	36.53
			1924	3.63	1.49	1.86	1.40	2.56	3.24	1.09	6.65	4.27	3.36	4.28	2.81	36.64
			1925	1.59	1.12	2.91	4.46	2.42	9.00	1.97	3.45	5.49	5.18	3.24	4.81	45.64
		Number of Days with Rainfall 0.01 Inch and over	1923	17	6	12	18	10	6	7	7	9	10	14	9	125
			1924	10	6	10	8	11	11	6	8	12	9	10	10	111
			1925	9	8	8	8	9	9	11	8	13	13	9	12	117
		Greatest Amount in 24 Hours	1923	2.12	0.77	0.72	1.20	0.98	2.30	0.50	0.52	0.55	1.55	1.07	0.58	—
			1924	1.06	0.65	0.73	0.78	1.34	0.91	0.46	2.10	1.50	1.35	1.42	0.90	—
			1925	0.41	0.66	0.98	2.41	0.97	3.71	0.60	1.74	2.37	1.77	1.20	2.20	—

Table XXIII.

COMPARISON OF CATCHES BY OPEN AND VEGETATION-SCREENED 5 INCH-DIAMETER RAIN-GAUGES (HEIGHT OF RIM 4 FT. ABOVE GROUND).

	June, 1925.	July, 1925.	Aug., 1925.	Sept., 1925.	Oct., 1925.	Nov., 1925.	Dec., 1925.	Jan., 1926.	Feb., 1926.	March, 1926.	April, 1926.	May, 1926.	Total for Year.	Percent- ages.
Control..... (Open)														
Rainfall.....	3.96	2.66	3.59	9.64	6.03	3.91	4.88	3.37	3.41	5.62	3.43	2.12	52.02	100
Number of days with 0.01 in. or more	10	7	8	16	14	11	18	11	18	16	10	8	147	—
Rainfall.....	7.95	2.73	6.81	19.49	12.46	7.20	7.95	6.34	3.32	10.54	6.60	3.17	94.56	181.7
Number of days with 0.01 in. or more	10	8	7	14	13	11	18	9	12	16	10	8	136	—
Fine drizzle and mist with wind	9	1	8	6	12	11	18	10	10	14	10	8	117	79
Normal showers....	—	2	—	8	2	—	—	—	7	1	—	—	20	13
Heavy downpour...	1	5	—	2	—	—	—	1	1	1	—	—	11	8

Italic figures indicate exceptional instance of catch of control greater than catch of condensation gauge.

Table XXV.

## RAINFALL DATA GAUGE UNDER FOREST CANOPY, FEBRUARY, 1923-JANUARY, 1925.

Elevation and Position.	Station.	Rainfall.	Year.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sep.	Oct.	Nov.	Dec.	Total Forest.	Total Exposed Control.
1,500 feet forest gauge (under high canopy)	Deepwells.	Total in inches....	1923	*	1.54	2.42	4.48	3.24	3.49	0.89	2.21	2.02	4.27	5.25	3.03	32.84	37.63
			1924	2.54	2.31	2.71	1.88	2.03	1.48	0.10	3.80	4.73	3.45	2.95	2.84	30.85	44.20
			1925	2.29	—	—	—	—	—	—	—	—	—	—	—	2.29	3.17
																65.98	85.00
																Mean Percentage.	
		Percentage of control	1923	—	56.8	87.6	87.5	89.0	119.9	71.7	75.4	66.2	103.8	92.09	86.3	85.11	—
			1924	69.7	65.5	89.7	64.6	68.5	61.0	16.3	65.9	80.1	72.3	67.3	66.5	65.61	—
			1925	72.2	—	—	—	—	—	—	—	—	—	—	—	72.20	—
																74.30	
		No. of days with rainfall 0.01 inch and over	1924	—	8	10	15	9	7	6	7	10	10	15	11	Total Forest.	Total Exposed Control.
			1924	10	5	12	8	9	7	5	13	14	9	13	10	108	134
			1925	9	—	—	—	—	—	—	—	—	—	—	—	115	144
																9	12
																232	290
		Difference in No. of rainy days compared with base	1923	—	3	5	2	1	4	3	1	1	3	1	0	—25	—
			1924	1	3	2	4	1	3	2	1	2	4	3	5	—20	—
			1925	3	—	—	—	—	—	—	—	—	—	—	—	—3	—
																—58	
																Less than the control.	
		Greatest amount in 24 hours forest	1923	—	0.57	1.78	1.07	2.10	1.12	0.45	0.90	0.82	2.27	2.60	0.90	—	—
			1924	1.05	0.81	0.93	0.69	0.94	0.45	0.01	0.58	2.40	1.23	0.77	0.93	—	—
			1925	0.74	—	—	—	—	—	—	—	—	—	—	—	—	—

\* No reading available.



Table XXV.

## RECORD OF FALLS OF SNOW ON BARRIER RANGE AND FOOTHILLS, 1922-1926.

Year.	May.	June.	July.	August.	October.
1922.....	—	—	—	<sup>x</sup> Slight.	—
1923.....	—	—	<sup>x</sup> Slight.	—	—
1924.....	<sup>x</sup> Slight.	—	—	<sup>x</sup> Heavy.	—
1925.....	—	—	<sup>x</sup> Heavy.	<sup>x</sup> Heavy.	—
1926.....	—	—	<sup>x</sup> Very Heavy.*	<sup>x</sup> Very Heavy.†	<sup>2x</sup> Slight.

\* On foothills as well.

† Three inches deep at Deepwalls, 1,725 feet remained 3 days in portions of forest adjacent ; damage done to young trees.

Table XXVI.

## RECORD OF HAIL STORMS AT DEEPWALLS, 1923-1926.

Station.	Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.	Remarks.
Deepwalls 1,725 feet	1923	—	—	x	—	x	—	—	—	—	—	—	—	2	Slight.
	1924	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	1925	—	—	—	—	x	—	—	—	—	—	—	—	1	Slight.
	1926	—	—	—	—	x2	x	x4	x5	—	—	—	—	12	All slight.
TOTAL....	—	—	—	—	—	—	—	—	—	—	—	—	—	15	

Table XXVII.

CLASSIFICATION OF WINDS AT { 8.30 A.M. } BY DIRECTION DEEPWALLS 1,725 FEET, YEARS 1924 AND 1925.  
 { 7 P.M. }

Direction from.	Year.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sep.	Oct.	Nov.	Dec.	Total.
		8.30 a.m.	8.30 a.m.	8.30 a.m.	8.30 a.m.	8.30 a.m.	8.30 a.m.	8.30 a.m.	8.30 a.m.	8.30 a.m.	8.30 a.m.	8.30 a.m.	8.30 a.m.	8.30 a.m.
N.....	1924	—	—	—	—	1	3	1	3	1	—	—	—	6
	1925	—	—	—	—	—	—	—	—	—	1	—	—	7
NSW.....	1924	—	—	—	—	—	2	—	—	—	—	—	—	—
	1925	1	1	—	—	4	10	8	3	1	—	—	—	27
NW.....	1924	5	6	7	8	10	11	9	7	8	14	12	6	100
	1925	8	6	9	7	5	13	12	11	18	19	6	23	144
NE.....	1924	—	—	—	—	—	—	—	—	—	—	—	—	—
	1925	—	1	—	—	—	—	1	—	—	—	—	2	3
E.....	1924	—	—	—	—	—	—	3	2	—	—	—	—	5
	1925	—	—	—	—	—	—	—	—	—	—	—	—	2
SE.....	1924	6	7	8	10	1	1	3	3	7	6	6	5	55
	1925	7	6	8	6	3	—	1	5	6	11	9	5	62
W.....	1924	—	—	—	—	—	1	—	—	—	—	—	—	—
	1925	—	—	—	—	1	2	1	—	—	1	—	—	4
SW.....	1924	—	—	—	—	—	1	—	—	—	—	—	—	—
	1925	—	—	—	1	—	1	—	—	—	—	—	1	2
Berg.....	1924	1	2	2	5	1	6	1	3	2	1	—	—	30
	1925	—	1	2	4	2	—	—	9	4	1	—	—	23
		28	39	36	30	28	48	47	46	47	50	40	44	445

Table XXVIII.

CLASSIFICATION OF WINDS AT  $\left\{ \begin{array}{l} 8.30 \text{ A.M.} \\ 7 \text{ P.M.} \end{array} \right\}$  BY FORCE (BEAUFORT SCALE) DEEPWALLS 1,725 FEET, YEARS 1924 AND 1925.

	Year.	Jan.		Feb.		March.		April.		May.		June.		July.		Aug.		Sep.		Oct.		Nov.		Dec.		Total.		
		8.30 a.m.	7 p.m.	8.30 a.m.	7 p.m.	8.30 a.m.	7 p.m.	8.30 a.m.	7 p.m.	8.30 a.m.	7 p.m.	8.30 a.m.	7 p.m.	8.30 a.m.	7 p.m.	8.30 a.m.	7 p.m.	8.30 a.m.	7 p.m.	8.30 a.m.	7 p.m.	8.30 a.m.	7 p.m.	8.30 a.m.	7 p.m.	8.30 a.m.	7 p.m.	
1	1-3 Light air.	12	11	10	7	11	11	5	11	7	8	10	7	11	1	10	3	9	2	13	3	11	9	8	10	117	83	
2	4-7 Light breeze	8	8	5	5	13	5	8	11	7	4	14	7	11	9	7	6	10	5	10	7	8	9	14	10	115	86	
3	8-12 Gentle breeze	—	3	4	3	3	4	6	8	5	8	3	4	3	9	5	6	7	13	7	2	4	6	2	4	49	70	
4	13-18 Moderate breeze	6	10	5	14	6	6	9	2	3	—	4	6	8	4	12	4	8	7	11	8	5	1	7	5	84	67	
5	19-24 Fresh breeze	—	1	4	3	3	1	—	1	1	3	2	2	2	8	1	6	3	5	2	6	3	5	3	7	20	44	
6	25-31 Strong breeze	1	4	3	—	3	3	—	—	3	2	4	4	4	8	7	2	6	8	4	4	6	—	3	7	44	48	
7	32-38 Moderate gale	—	1	1	—	—	1	1	1	1	2	1	2	2	2	2	4	3	1	2	2	1	2	3	1	5	15	
8	39-46 Fresh gale	—	1	—	—	—	—	—	1	—	—	1	1	2	2	2	1	1	—	1	2	1	—	—	—	2	9	8
9	47-54 Strong gale	—	—	—	—	—	—	—	—	1	—	—	—	—	2	—	1	—	—	—	—	—	—	1	—	—	1	1
		25	39	30	34	36	31	30	35	28	24	44	40	46	46	46	36	47	44	50	38	40	33	42	45	467	445	



Table XXIX (a).

EVAPORATION MEANS AND ABSOLUTE MAXIMA, DEEPWALLS, JULY, 1925-JUNE, 1926.

Station Nature.	Evaporation.*	July, 1925.	August, 1925.	September, 1925.	October, 1925.	November, 1925.	December, 1925.	January, 1926.	February, 1926.	March, 1926.	April, 1926.	May, 1926.	June, 1926.	Grand Absolute Maximum in 24 Hours e.e.
Full light - intensity height above ground 12 inches full atmos- pheric conditions	Mean evaporation in 24 hours e.e.	10·679	14·669	11·039	8·259	10·736	8·910	11·339	8·25	7·788	10·290	10·389	11·135	= 58·547  Berg Wind. Force 4. Hot clear.
	Absolute maximum evaporation e.e.	33·312	56·148	58·547	26·250	29·154	27·951	22·007	22·31	24·292	46·738	32·765	28·900	
	Weather at date of absolute maximum Total for 12 months = 3,595·699 e.e.	Still Warm Clear	Berg Wind Force 5 Hot, clear	Berg Wind Force 4 Hot, clear	N.W. Wind Force 2 Warm, clear	N.W. Wind Force 1 Warm, cloudy	Berg Wind Force 2 Warm, clear	N.W. Wind Force 3 Warm, clear	N.W. Wind Force 3 Warm, clear	Berg Wind Force 2 Warm, clear	Berg Wind Force 2-4 Hot, clear	Berg Wind Force 3 Warm, clear	Berg Wind Force 3 Warm, clear	
Table XXIX (b). Light intensity $\frac{1}{10}$ height above ground 12 inches	Mean evaporation in 24 hours e.e.	8·604	9·874	5·835	5·218	7·503	5·988	6·280	6·648	4·478	7·545	9·157	—	= 40·058  Berg Wind. Force 5. Hot clear.
	Absolute maximum evaporation e.e.	30·338	40·058	36·145	21·282	21·163	20·649	13·650	19·279	20·443	34·625	29·880	—	
	Weather at date of absolute maximum Total for 11 months = 2,350·401 e.e.	Still Warm Clear	Berg Wind Force 5 Hot, clear	Berg Wind Force 4 Hot, clear	N.W. Wind Force 2 Warm, clear	N.W. Wind Force 1 Warm, cloudy	Berg Wind Force 2 Warm, clear	N.W. Wind Force 3 Warm, clear	N.W. Wind Force 3 Warm, clear	Berg Wind Force 2 Warm, clear	Berg Wind Force 2-4 Hot, clear	Berg Wind Force 3 Warm, clear	— — —	

\* Livingston Atmometers (spherical) with Thome valves; standardized.



Table XXX.

INFLUENCE OF BERG WINDS UPON RATE OF EVAPORATION, DEEPWALLS, 1,725 FEET, *August*, 1925.

	Humidity.	Berg Winds.	Evaporation in Grammes.*
	%		
1...	31.00	Berg 2.....	31.096
2...	97.00		4.042
3...	99.50		3.779
4...	90.00		22.900
5...	38.00		26.029
6...	97.00		0.001
7...	89.50		18.264
8...	34.75	Berg 2.....	56.148
9...	30.00		7.132
10...	81.75		4.859
11...	97.00		0.001
12...	97.75		0.550
13...	81.00		7.969
14...	84.00		22.495
15...	38.00	Berg 2.....	29.420
16...	43.00	Berg 5.....	33.655
17...	82.00		10.915
18...	76.00		17.735
19...	84.50		13.413
20...	29.00	Berg 2.....	38.155
21...	76.00		7.950
22...	77.75		20.502
23...	36.00	Berg 3 night.....	36.100
24...	25.00	Berg 3.....	32.515
25...	97.25		1.835
26...	90.00		8.379
27...	82.25		7.116
28...	92.25		19.299
29...	30.00	Berg 5.....	29.746
30...	98.00		20.785
31...	58.00	Berg 1 (short duration)....	8.615
Sums	2,163.25	Total.....	541.400
Mean	69.78	Mean.....	17.464
		Corrected mean (0.84 correction).....	= 14.669

\* Standardized Livingston Atmometer (spherical) with Thome non-absorbent valves.

Table XXXI.

## ZOOBIOTIC ASSOCIATES.

Zoological Name.	Common Name.	Function and Remarks.
<i>Ephydatia fluviatilis</i> .....	Fresh-water sponge.....	Occurs at the base of <i>Phragmites</i> and <i>Typha</i> , as a felt-like mass, especially in pools or slow-flowing streams; dies down in winter.
<i>Helicidae</i> —various.....	Snails.....	Frequent on boles and foliage of forest trees, but do slight harm.
<i>Helix aspersa</i> (exotic).....	Common snail.....	Locally abundant; does much harm to young trees in seedling stages.
<i>Achatina zebra</i> .....	Great snail.....	Frequent, but does slight harm.
<i>Allolobophora</i> spp.....	Earthworms.....	—
<i>Lumbricus rubellus</i> and other exotic <i>Lumbricidae</i>	Earthworms.....	Throughout the region in upper soil layers, but density per acre varies directly with soil quality.
<i>Acanthodrilidae</i> .....	Earthworms.....	The worms assist in aerating the soils.
Millipedes ( <i>Diplopoda</i> ).....	"Wireworms" (misnomer)	Destructive to vegetation, especially in cultivated areas.
INSECTS.		
<i>Orthoptera</i> —		
<i>Furculidae</i> .....	Earwigs.....	Slightly destructive.
<i>Phasmidae</i> (especially <i>Batrachoderma</i> spp.)	Stick insects.....	Slightly destructive to foliage of indigenous seedling trees.
<i>Acrididae</i> .....	Short-horned grasshoppers	—
( <i>Phymateus morbillosus</i> )..	Non-migratory locust...	Destroys foliage of <i>Virgilia capensis</i> .
<i>Locustidae</i> .....	Long-horned grasshoppers	Slightly destructive to various herbs.
<i>Gryllidae</i> .....	Crickets.....	Destructive to roots of various young trees.
( <i>Gryllotalpa vulgaris</i> )....	Mole cricket.....	—
<i>Hymenoptera</i> —		
<i>Apis mellifera</i> .....	Honey bee.....	Pollinates various spp.— <i>vide</i> "Agents of Pollination" Table 2, Appendix 1.
<i>Apis castra</i> .....	Wild honey bee.....	Pollinates various spp.— <i>vide</i> "Agents of Pollination" Table 2, Appendix 1.
<i>Anthophora madecassa</i> ...	Humble bee.....	Pollinates special flowers— <i>vide</i> Table 2, Appendix 1.
<i>Xylocopa</i> spp. ( <i>olivacea</i> , <i>capensis</i> )	Carpenter bees.....	Cut through bases of the flowers of certain spp., extract nectar, but do not pollinate flowers.
<i>Vespidæ</i> and <i>Eumenidae</i> ( <i>Polistes</i> and <i>Eumenes</i> )	Social and solitary wasps	Occasionally pollinate.
<i>Tenthredinidae</i> .....	Saw flies.....	Slightly damage foliage when this is young.
<i>Cynipidae</i> .....	Gall flies.....	Slightly damage foliage, especially that of <i>Rhus</i> spp., <i>Trichocladus crinitus</i> .
<i>Ichneumonidae</i> .....	Ichneumon flies.....	These are parasitic on a number of other insects, especially on some of the <i>Lepidopterous</i> larvae destructive to seeds of forest spp.
<i>Coleoptera</i> —		
<i>Lamellicornia</i> .....	Chaters.....	Larvae are root-feeders, adults attack foliage and young stems.
<i>Chrysomelidae</i> .....	Leaf beetles.....	These are moderately destructive to leaves of various spp. of tree seedlings.
<i>Cerambycidae</i> .....	Longicorns.....	Attack stems of large trees, notably <i>Celastrus acuminatus</i> , <i>C. peduncularis</i> , <i>Ocotea bulbata</i> .
<i>Cureulionidae</i> (including the <i>Scolytidae</i> )	Weevils.....	An unidentified larvae does much harm to sapling and seedling <i>Ocotea</i> , boring the pith and destroying the young wood. Very abundant—destroyers of boles of trees.
<i>Lepidoptera</i> .....	Butterflies and moths..	Numerous, but most of them of little ecological interest.
<i>Papilio demodocus</i> .....	Orange butterfly.....	Larvae destroy foliage, but adults pollinate various spp. notably <i>Platylophus</i> , <i>Canonia</i> , <i>Halleria</i> , <i>Burchellia</i> .
<i>Pyrausta cardui</i> .....	Painted Lady.....	Pollinates various flowers of the <i>Machaia</i> .



Table XXXI.—(Continued).

## ZOOBIOTIC ASSOCIATES—(continued.)

Zoological Name.	Common Name.	Function and Remarks.
Various moths, notably:— Nudaurelia (Atherca) cytherea	Christmas worm.....	Causes severe defoliation (larval stage) to Protea, Rhus, and exotic plants. (Pine, Eucalypts.)
Sphingidae—various.....	—	Larvae bore in timber trees.
Noctuidae—various.....	Cut worms.....	Larvae destroy regeneration of all species of trees, by nipping off the seedlings at the collars.
Tortricidae—various.....	—	Larvae defoliate young trees and bind up the dry leaves into "nests."
Tineidae.....	—	Larvae cause some damage to foliage of tree seedlings.
<i>Hemiptera</i> — Antestia variegata..... Holopterna vulga..... Aphidae.....	Fruit bug..... Stink bug..... Plant lice.....	Punctures fruits of various forest species. Punctures new shoots of various species. Frequent in flowers of Olinia cymosa, causing much damage; occasionally on the foliage of Vergilia.
Coccidae.....	Scale insects.....	Locally abundant in beds of Olea laurifolia seedlings, causing poor growth and death. The disease does not spread rapidly.
Various unidentified mites...	—	Detrimental to the foliage of various species. One species forms pockets on the foliage of Ocotea bullata (Phillips, J.F., 1924) (1).
<b>BIRDS.</b>		
Amydrus morio.....	Roovlerk spreeuw.....	Seed dispersal and insect destruction.
Spreo bicolor.....	Witgat spreeuw.....	Seed dispersal and insect destruction.
Lamprocolius melanogaster..	Black-bellied starling.....	Seed dispersal and insect destruction.
Oriolus larvatus.....	Black-headed oriole.....	Seed dispersal; destruction of insects, especially of honey bees.
Hyphantornis velatus.....	Masked weaver.....	Seed dispersal along water-courses; occasionally a pollinator.
Situgra capensis.....	Cape weaver.....	Seed dispersal along water-courses; occasionally a pollinator.
Estrilda astrilda.....	Waxbill.....	Dispersal of small seeds, occasionally a pollinator.
Serinus canicollis.....	Cape canary.....	Dispersal of small seeds.
Promerops cafer.....	Cape sugar bird.....	Pollinator.
Cinnyris afer.....	Greater sugarbird.....	Pollinator.
Cinnyris chalybeus.....	Lesser sugarbird.....	Pollinator.
Cinnyris amethystinus.....	Black sugarbird.....	Pollinator.
Zosterops capensis.....	Cape white eye.....	Pollinator; destroys small insects (Coccidae), and disperses small seeds.
Parus afer.....	Blackbreasted tit.....	Destroys insects, especially Coccidae.
Aegithalus minutus.....	Kapokvogel.....	Destroys small insects.
Camaroptera olivacea.....	—	Destroys small insects.
Turdus olivaceus.....	Cape thrush.....	Destroys insects.
Cossypha caffra.....	Cape robin.....	Destroys insects.
Cossypha bicolor.....	Noisy robin.....	Destroys insects.
Dicurus afer.....	—	Kills large numbers of honey bees.
Campophaga nigra.....	Black cuckoo shrike.....	Destroys insects.
Campophaga hartlaubi.....	Yellow cuckoo shrike.....	Destroys insects.
Uppa africana.....	"Hoopoe".....	Destroys insects.
Irisor viridis.....	Wood hoopoe.....	Destroys insects.
Caprimulgus pectoralis.....	Cape nightjar.....	Destroys insects.
Colius striatus.....	Muisvogel.....	Seed dispersal.
Lophoceros nolanoleucus.....	Crowned hornbill.....	Seed dispersal; destroys insects.
Campothera notata.....	Knysna woodpecker.....	Destroys insects.
Dendropicus cardinalis.....	Cardinal woodpecker.....	Destroys insects.
Indicator major.....	Yellow honey bird.....	Destroys insects.
Indicator minor.....	Lesser honey bird.....	Destroys smaller insects.
Cuculus solitarius.....	"Piet-myn-vrouw".....	Destroys insects.
Chrysococcyx smaragdineus..	Green cuckoo.....	Destroys insects.
C. cupreus.....	Golden cuckoo.....	Destroys insects.
Centropus Burchelli.....	Vlei lourie.....	Destroys insects.
Turacus corythaix*.....	"Lourie".....	Seed dispersal.
Columba phoenota.....	Bush dove.....	Seed dispersal.
Columba arquatrix†.....	Bush dove.....	Seed dispersal.
Turtur capicola.....	Turtle dove.....	Seed dispersal.
Chalcopelia afra.....	"Blaarduij".....	Seed dispersal.
Haplopelia larvata.....	Cinnamon dove.....	Seed dispersal.
Stephanibyx coronata.....	Crowned lapwing.....	Destroys insects, and disperses small seeds.

\* Vide Phillips, 1927; (7).

† Vide Phillips, 1928; (7).

Table XXXI.—(Continued).

## ZOOBIOTIC ASSOCIATES—(continued).

Zoological Name.	Common Name.	Function and Remarks.
<b>MAMMALS.</b>		
Potamochoerus choeropotamus*	Wild or bush pig.....	Disperses seeds; destroys seeds.
Tragelaphus sylvaticus.....	Bushbuck.....	Dispersal and destruction of seeds; destruction of several species of tree-scedlings.
Cephalophus monticola.....	Bluebuck.....	Dispersal, and slight destruction of seeds.
Pediotragus tragulus.....	Grijsbok.....	Dispersal of seeds; destruction of regeneration of certain species of tree-scedlings.
Lepus capensis.....	Cape hare.....	Destruction of marginal regeneration, coastal forests.
Dendromys melanotis.....	Grey treemouse.....	Seed dispersal and destruction.
Bathyergus maritimus.....	Sand mole.....	Destroys bulbs and roots.
Hystrix africae-australis.....	South African porcupine	Destroys bulbs and roots.
Procavia capensis.....	Rock rabbit.....	Destroys foliage, bulbs, roots.
Elephas africanus (sub-species)†	Knysna-type of African elephant	Seed dispersal and destruction of vegetation. (Phillips, 1925, (4).
Rousettus collaris.....	Common fruit bat.....	Dispersal and destruction of seeds.
Cercocepithecus pygerythrus..	Vervet monkey.....	Dispersal and destruction of seed; destruction of bulbs, roots, and insects.
Choiropithecus porcarius....	Baboon.....	Dispersal and destruction of seed; destruction of bulbs, roots, and insects.
Felis caffra.....	Wild cat.....	Occasionally disperses drupes of
Mellivora ratel.....	Ratel.....	Destruction of honey bees and of honey.

*Man*.—The influence of man has been discussed under Chapter III†, and needs no further treatment here.\*

\* Potamochoerus: *vide* J. F. V. Phillips, 1926 (6).

† Elephant: *vide* J. F. V. Phillips, 1925 (4).

‡ Influence of Man: *vide* also Chapter (4).

\* Phillips, 1930: (1) considers man as part of the *plant-and-animal, or biotic community*—as in exploited forest at Knysna.

## Chapter III.

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THE FORESTS: A BRIEF SUMMARY OF  
LITERATURE AND HISTORY.



## CHAPTER III.

## THE FORESTS: A BRIEF SUMMARY OF LITERATURE AND HISTORY.

## LITERATURE.

Although the forests of the Knysna have been known to Europeans since 1711, and although the region was visited as early as 1772 by Thunberg, and since then by a number of other eminent botanists, there is practically no literature of phytogeographic or ecologic nature.

The writer, in a special Departmental monograph entitled "The Midland Forests: a Brief Historical Account of their Management," has shown that the fragmentary records in the possession of the Forest Department are of purely historic or semi-sylvicultural interest only. Leaving, then, purely forestal reports out of consideration, we find that, until the appointment of Dr. L. Pappe as First Colonial Botanist in 1858, no reliable descriptions of the forests and macchia of the region were available. Apart from passing remarks by Lichtenstein (1812), the region received scant mention by any of the botanists who had visited it.

Pappe visited the forests and macchia about 1859-60, and in his annual report describes their nature. He records the unsatisfactory manner in which the forests were being conserved. First he declares to be taking heavy toll year by year. He drew upon the forests for herbarium and timber specimens, and shortly after prepared his very useful little work, "*Silva Capensis*" (1862: London), in which brief descriptions of the chief timber species were given, together with notes concerning their habits, habitats, and uses.

On the death of Pappe in 1862, the versatile Dr. H. Croumbie Brown, was appointed to the post. He visited the Knysna about 1862-3, and in his report describes the forests and, to a somewhat greater extent, the various abuses to which they were subjected. In 1887 appeared his "Management of Crown Forests at the Cape," in which he gives many notes of interest to the present-day ecologist paying attention to succession on burned or exploited forest-land.

In 1898 E. Knoblauch published an autecological contribution to our knowledge of certain forest trees and shrubs of the Knysna, entitled "*Oekologische Anatomie der Holzpflanzen die Zuid Afrikanischen Immergrünen Busch-region*" (Tubingen: 1896). This work is difficult to obtain.

In the same year Marloth and A. F. W. Schimper visited the region, and in "*Das Kapland*" (1908: pp. 187-197, 207-210) record their impressions.

Marloth discusses the extent and climatic factors of the forests, and lists the chief species of trees. Adopting figures supplied by Conservator C. B. McNaughton, he sets forth the composition of the forests, in terms of percentage stocking of the various tree species; he arranges the species into five height-classes. Short lists of forest shrubs, herbs, ferns, and epiphytes are given, while the vegetation of the forest margins is dealt with concisely. Interesting points concerning the general ecology of the forest species receive notice. A useful account of the original extent of South African forests is furnished.

A. F. W. Schimper, under the title of "Der Knysna Wald,"\* presents an excellent account of the nature and general ecology of the forests and macchia: we are fortunate in possessing even this all too brief description from the facile pen of the noted phytogeographer. Schimper briefly discusses the present extent of the forests, and leans to the opinion that they did not at one time entirely cover the face of the country, but that existing areas of macchia, on the advent of the white man, had been very considerably increased in extent by axe and flame. He outlines the nature of the habitat, the nature and composition of the forests, and notes points of difference between them and tropical ones. His remarks on this subject are so much to the point that they bear citation here, verbatim:—

" . . . Mit dem tropischen teilt der temperierte Regenwald den hygrophilen charakter, das immergrüne Laub, die Holzlianen und, in floristischer Hinsicht, die bunte Mischung aus verschiedenen Arten. Er unterscheidet sich von demselben durch die reichere Verästelung der Bäume, die geringere Grösse der Blätter, womit geringere Frondosität und derbere Laubbeschaffenheit zusammenhängen, Fehlen der Flügel an den Baumstämmen, Seltenheit der Traufelspitze, geringere Mannigfaltigkeit der Lianen, geringere Menge und Mannigfaltigkeit phanerogamischer Epiphyten, Reichtum an epiphytischen Moosen und Flechten. In jeder Hinsicht ist durch das eben Gesagte der Knysna-wald ökologisch charakterisiert. . . . "

He touches upon the irregular height of the forest canopy, the mixed nature of the forests, describes certain of the trees and shrubs, and refers to various ecological points. Gerhard (1902) describes the leaf-structure of several Knysna Forest species.

T. R. Sim, in his valuable "Forests and Forest Flora of the Cape Colony" (Aberdeen, 1907), gives a short account of the forests, and indicates several species of trees peculiar to, or absent from, them. In the descriptions of the forest and scrub species of the Colony, many interesting points are given re habits, habitats, and communities.

J. S. Henkel (1912) in a brief paper describes certain features of the forests.

I. B. Pole-Evans (1920) dismisses the forests of the Knysna in a single paragraph, merely listing some of the species, and pointing out the presence of *Virgilia*, which does not occur in the eastern forests.

In a later paper (1922: 50), Evans considers the forests of the Knysna as mere outliers of the forests on the southeastern slopes of the Drakensberg.

J. F. V. Phillips (*vide* Bibliography for references) has contributed to the ecology of several of the more important species of forest trees and forest animals. In a Forest Department report, Phillips (1924: ii) has described the principal features of the history of forest management for the period 1778-1909.

Bews (1925), in his stimulating "Plant Forms," laden with suggestive material along the line of the use of the phylogenetic method in taxonomy, refers to the Knysna Forests. He notes the successional role of *Virgilia*, lists the more important species of trees and shrubs, and then states that the forests are but outliers of the eastern forests, within the southwestern region. The forests are considered to be "intimately connected with the southwestern vegetation," which they replace in the process of succession.

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\* Das Kapland: 207-210.

Reference to the description of the region on vegetation maps by various botanists between 1843 and 1923 is not out of place here :—

Date.	Author.	Description.
1843.....	Drege, J. F.....	IVC. included in his " <i>Terra inferior australis</i> ."
1871.....	Grisebach.....	<i>Kapflora</i> , in common with practically the whole of the country south of the Orange River.
1880.....	Rehman.....	<i>Waldgebiet</i> , (from 22 deg.-26 deg. E. long. approx.)
1882.....	Engler, A.....	<i>Südliches Kapland</i> .
1886.....	Bolus, H.....	<i>Southwestern region</i> . . . included in.
1887.....	Drude.....	<i>Immergrüne Waldregion</i> , as contrasted with the <i>Immergrüne Buschregion</i> (Macchia) of the Cape.
1898.....	A. F. W. Schimper.....	<i>Regenwald</i> , as contrasted with the Macchia of the Cape. (Hartlaubholz.)
1905.....	Bolus.....	<i>South-western region</i> (as in 1886).
1908.....	Marloth.....	<i>Waldprovinz</i> or <i>Südl. Waldgebiet</i> , whereas he terms the Cape flora " <i>Reich der Kapflora</i> ."
1920.....	Pole Evans.....	<i>South-western veldt</i> , in common with the flora of the Cape Peninsula.
1923.....	Shantz and Marbut.....	<i>Temperate Rain Forest</i> .

\* Tansley (1913:32) cites the Knysna Forests as an example of Brockmann-Jerosch's (1912) "*Laurisilva*."

J. F. Phillips prefers to term the region that of "*Temperate-form Subtropical Forest*," for the reasons that *climatically* and *constitutionally* the Knysna Forests are more temperate than those of the eastern Cape, of Natal, and of the Transvaal, and that at the same time they are composed of species definitely derived from tropical ones. Ecologically, too, they show marked signs of having been derived from the tropical forests of east and central Africa.\*

The region has been visited by various botanists interested in the collection and description of the plants. Of these, the better known are as follows :—

Date.	Botanist.	Remarks.
1772.....	Thunberg, Carl.....	(1823). Collected and described a large number of plants.
1773.....	Thunberg, Carl.....	(1823). Collected and described further plants.
1772.....	Auge, J.....	Collected with Thunberg.
1773.....	Masson, F.....	Collected with Thunberg.
1775.....	Sparrmann, A.....	Collected.
1798-1803...	Niven, J.....	Collected.
1803.....	Lichtenstein, H.....	Collected. Remarkd on region (1812).
1814.....	Burchell, W. J.....	Collected.
1817-1822...	Bowie, J.....	Collected.
1829-1834...	Drege, J.....	Collected.
1860 (circa)...	Pappe, L.....	Collected. Remarkd on Forests.
1862.....	Brown, J. Croumbie.....	Described Forests and the abuses to which they were being subjected.
1870.....	Bolus, H.....	Collected and described.
1875-80.....	Rehmann, A.....	Collected. Remarkd on region (1880-1881).
1877.....	Schlechter, R.....	Collected.
1894.....	Penther, A.....	Collected.
1897.....	Galpin, E.....	Collected.
1898.....	Marloth, R.....	Outlined nature of Forests and Macchia (1908).
1898.....	Schimper, A. F. W.....	Contributed a short note on the Forests ( <i>vide</i> Marloth 1908: 207-210).

More recently, much collecting and identifying have been done by H. G. Fourcade, S. Schönland, and others.

The more important literature relating to the systematics of the region is listed in the Bibliography.

\* See Chapter VIII.

## HISTORY OF THE FORESTS.

(1) *Prior to the Advent of the European.*

Reliable information concerning the Knysna region ere its occupation by the white man is extremely meagre. The western forests of "Houteniqualand," or of the "Outeniquabergen," as they were then called, were actually discovered by the Dutch about 1711, but no descriptions of these at that date are available. Although these western forests were visited again in 1727 by the then Governor of the settlement at the Cape, it was not until 1778 that the region in which we are directly interested was entered by Dutch settlers. The latter took up their abode in the vicinity of Bahia Formosa, or, as it was in 1778 re-christened, Plettenberg's Bay. What the nature of the area was on the coming of these settlers will never be known fully, but several references from old records, and careful study of the plant succession itself, lead one to conclude that the Outeniqua, a semi-nomadic tribe of Bushman-Hottentots of small stature and primitive intelligence, were denizens of the forests and surrounds, and were to some degree responsible for forest destruction. Their hunting pits, utensils, and middens may be found in forest and macehia alike.

Diaz and Da Gama in the late fifteenth century, in their logs, refer to dense smoke banks that hung over the country as black palls, the flames themselves at times being visible to the mariners several miles out at sea. While much of the smoke may have arisen from firing of the macehia contiguous to the forests, there is little doubt that forest itself too often formed the fuel for the flames. Fires usually originate along the margins of South African forests, but in dry spells these can readily arise within the latter. The hunting pits relict of the days of the Outeniqua are to be found in the heart of the forests, testifying that the pygmies were indeed forest frequenters. It is significant that pits are found in larger or smaller macehia "eilands" (Dutch for "islands") occurring in the midst of forest: the origin of such "eilands" it is permissible to attribute to the destructive propensities of the extinct tribe of hunters responsible for the making of the pits. The depth of charred roots and stumps, the depth and nature of incinerated layers of soil, the depth of humus, and the nature of the plant communities in the vicinity of such pits, give clues to the ages of the "eilands."

Animals such as elephant and buffalo were hunted, and if wounded and at bay, were often "smoked out" by the easy means of firing the vegetation in which they had taken up their stand.

What it is desired to emphasize is that, while forest devastation received a fillip during the first century of the occupation by the European, *actual destruction did occur long ere he entered the land.*

The origin of fires from lightning, it might be argued, would not be uncommon throughout the ages. It is necessary, therefore, to record that it is extremely seldom that lightning-struck vegetation continues to burn after the initial singeing: moreover, reference to the chapter on Climate (Chapter 11) will show that lightning extremely rarely occurs in the greater portion of the region.\*

As the Outeniqua herded no stock and had little use for timber in his household economy, he did no harm in the directions of grazing stock in and exploiting forest.

The original extent of the forests is discussed under a special section in Chapter X (pp. 233-234).

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\* Fires due to lightning have been recorded from other parts of South Africa.



(2) *Since the Advent of the European.*

The settlers in the vicinity of Plettenberg Bay, about 1779-80 commenced to draw upon the forests for timber; they also cleared portions of ground of forest, bush, and macehia for the growing of crops and the pasturing of cattle. In addition to the settlement at the bay, a "Company's Woodcutters' Post" was established on the site of the present town of George, 1777-78. Le Valliant, the noted French naturalist who toured the region in 1781, camped at the post, and describes in his "Travels" (1783) how timber was exploited by the servants of the Company, and was transported overland to the distant Cape. Le Valliant is further informative in that he writes of the degenerate hewers of timber living in the vicinity of Plettenberg Bay, in the localities known as "De Poort" and "Wittedrift." These people cleared forest for the sake of the timber, which was sold to the Resident at the bay, and also for tilling and grazing purposes.

As the detailed records of forest management are given in J. F. Phillips's (1924: ii) "The Midland Forests: a Brief Historical Account of their Management," there is no need for a protracted description of the gradual increase in forest devastation by axe and flame until the introduction of an adequate system of conservation was at last brought about, through gradual evolution of policy, between the years 1874 and 1883. It will be sufficient to summarize here the history of treatment of the forest between 1778 and 1883.

Period.	History of Treatment.
1778-1811...	Commencement of exploitation. Clearing of Forest for agricultural needs.
1812-1821...	Introduction of some measure of control by the British Admiralty. Felling, burning, and general destruction still continued, as no active steps were taken to prevent abuses.
1822-1855...	Forest devastation at its height; reckless fellings and burning the order of the day, despite the formation of a weak Forest staff in 1847.
1856-1873...	Forest abuses slightly decreased in degree, but much felling and burning still continued although the Forest staff was larger and more active than formerly.
1874-1882...	Further decrease in abuses, chiefly due to the improved staff. First attempt at systematic management made by Conservator, Captain Harison.
1883.....	Abuses gradually decreased until they became practically non-existent by about 1890. Improved systems of conservation and management were gradually introduced.

Points of considerable ecological importance arise from a study of the forest management between 1778 and the present day. Briefly, the more important are the following:—

1. Until 1882, trees required for exploitation purposes were culled from any portion of the forests—perhaps many years elapsing ere the removal of a second tree adjacent to the site of one removed previously. Large exploitation areas were thus non-existent, and the natural regeneration arising on the sites of the single trees removed, not being exposed to severe insolation or competition with weeds, comparatively speedily healed the rupture in the canopy.

The method of exploitation thus nearly approached the natural manner in which old age, wind storms, disease, and other factors eliminate individual trees, thus presenting conditions favourable to the establishment and growth of regeneration. After 1882, definite portions of forest were exploited, often fairly severely. The concentration of fellings resulted in the excessive rupture of the canopy, deterioration or destruction of forest conditions, and general depreciation of the value of the forest sylviculturally and financially. Weeds colonized the opened-up areas, and either gave way to shrub and tree stages slowly, or else remained in possession as subclimax communities.

2. For many years the only species exploited were the two *Podocarps* and *Ocotea bullata*; small quantities of *Apodytes*, *Olinia*, and *Curtisia* were also drawn from the forests in certain localities. *Olea laurifolia*, the most abundant

species in the forests, was not exploited until late in the "nineties" of last century. The tendency was for the number of large individuals of the *Podocarps* and *Ocotca* to be decreased considerably, as compared with those of other tree species. Indeed, it was urged by Hutchins (1888-1890) that "ring-barking" of the *Olca* and other "inferior" species was essential to the maintenance of the proper stocking of the more valuable species.

3. For many years the finest trees only were felled, the unsound, diseased, malformed individuals being left in the forests: the quality of the forests was thus much depreciated.

4. For a time the minimum girth limits of exploitation were too low, with the result that most of the large but as yet immature trees were removed, with consequent reduction of the general height of the forest canopy and extreme introduction of insolation to the seedling and sapling stages.

5. Systematic firing of *macchia* on the margins of the forests, as well as far removed from them, was initiated, the outcome being the destruction of the seral stages leading from *macchia* to forest, and the throwing back of the succession to zero.

6. The introduction of exotic trees—chiefly eucalypts, acacias, pines—into *macchia*, along the forest margins, and into opened-up areas in the forests themselves, was commenced in the "nineties." This has, in some respects, complicated successional changes, and may yet prove a factor of the very greatest economic as well as ecologic importance. Artificial climaxes of fast-growing, moisture-voracious, and strongly regenerating exotics, brought into being in the midst of a natural vegetation much disturbed and not particularly aggressive, may provide interesting material for study from various aspects in future years.

## Chapter IV.

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THE PLANT SUCCESSION: PRINCIPAL STAGES  
OF THE  
FOUR SERIES.  
(INITIAL and MEDIAL)



## CHAPTER IV.

## THE PLANT SUCCESSION: PRINCIPAL STAGES OF THE FOUR SERES (INITIAL AND MEDIAL).

The principal stages of the four seres—the *Hydrosere* (the stages originating in free water surfaces or very moist soil), the *Halosere* (the stages originating in saline water or on saline soil), the *Psammosere* (the stages originating on sandy surfaces), and the *Lithosere* (the stages originating on rocky surfaces)—are discussed briefly, in order of the plant succession; initial stages first, medial stages later. It will be seen that the four seres converge on macchia, from which scrub, bush, and forest develop in due course; accordingly stages of higher development than macchia are not dealt with in this chapter, with the exception of several anomalous communities in the *Hydrosere*. Scrub and bush are described in Chapter V, and in Chapters VI, VII, IX, and X forest is treated. In Chapter VIII the general tendencies of the plant succession within the Knysna region are summarized. The schematic chart (in separate cover) gives a graphic impression of the principal stages of the four seres and of their inter-relations.

The seres are described in the following order:—

- (1) The *Hydrosere*.
- (2) The *Halosere*.
- (3) The *Psammosere*—
  - (a) On the coast.
  - (b) Inland.
- (4) The *Lithosere*—
  - (a) Inland.
  - (b) On the coast.

The data submitted, based where possible on *quadrat* studies, but for the greater part on *inference* and *sequence* studies and observations, are to be considered preliminary, and in instances incomplete. Further *quadrat* and *sequence* studies conducted over a decade or two, are likely to produce information concerning the several seres and the relationships of the various stages, at present not available—at the same time the present account prepares the way for a later and fuller monograph.

## THE HYDROSERE.

Areas.—Free water surfaces—rivers, streams, vleis, flushes.

The pioneer communities commence life in free water. Through reaction of community upon the habitat—especially on the moisture content of the substratum—and the reciprocal reaction of habitat on community, successive stages proceeding toward the mesophytic are accompanied by equivalent advances of the moisture conditions toward the normal.

Apart from the lakes of George and Knysna, the region to-day does not present any great development of primary water surfaces, but at the same time numerous fragmentary examples are to be found. When we realise the very fair extent of soil now bearing the penultimate and ultimate stages of the hydrosere, it appears that in past ages there must have been a greater development of water surfaces or of very moist, swampy areas.

The various initial and medial stages to be described are not always found occurring in the regular, diagrammatic zonation that may be supposed from a glance at the schematic chart. These are indeed often interrupted, either through the absence of one particular stage, the interpolation of another, or the earlier or later appearance of yet another.

Careful study of the several stages and of the habitat conditions controlling and in turn controlled by these, enables one to piece together the more important stages in the succession, even if these be separated in space.

The major stages only are described.

(1) *The Stage of Submerged and Partially Submerged Hydrophytes.*

The plants occurring in this stage are rooted in the mud and ooze at the bottom of the water surfaces. Where this stage is represented, the water is seldom more than from two to three feet deep, and usually about one foot to one and a half feet only. The water of the "vleis" and "flushes" is usually very poorly aerated, contains much organic matter, and shows pH values between pH 5.8 and 6.5; the marginal water of larger streams and rivers, however, is less acid, the values lying between pH 6.2 and pH 6.8. These values naturally vary with degree of rainfall—the water being more acid immediately after a heavy fall, or during times of stagnation as the result of drought. A point of some importance so far as light-intensity at the various depths is concerned, is that the water is usually from pale brown to very dark brown, although entirely transparent. This is found to be due to organic matter in solution. Examination of the submerged communities in dark-coloured water has shown that these are floristically poor, and in addition, are frequently of low absolute density of stocking.

The usual conditions in fresh water are as follows:—

Well represented are *Potamogeton fluitans*, *P. americanus*, and less often *P. lucens*; these, in deeper water, are entirely covered, but in shallower "vleis" and along the margins of slow-flowing streams often have their leaves above the water-level, or resting thereon. They form dense consocieties or associates, and considerably decrease the light-intensity for their own regeneration and for such Characeae as may be present. On occasion their foliage thins out, and doubtless it is at such times that the sunken achenes germinate and produce young plants. *Ceratophyllum demersum* is a common plant in certain water bodies, is rare or entirely absent in others. Where abundant—as in some of the George and Knysna lakes—it forms dense consocieties, or may form a layer societies to the *Potamogetons*. Another interesting plant of this zone is *Lagarosiphon muscoides*, forming close consocieties from eight to sixteen inches in height, or growing in associates with *Crassula inanis*; it very often occurs in later stages as a semi-aquatic. *Crassula inanis* behaves in a similar manner.

In many localities a characteristic plant of the submerged zone is *Myriophyllum spicatum*, sometimes forming associates with the species above mentioned, but more often in pure layer societies. *Utricularia exoleta* favours muddy-bottomed bodies and river estuaries; it may either float or be submerged.

As pointed out by Bews (1920: 396) in describing this stage for the coast-belt of Natal, these plants are by no means wholly submerged, but may often be found with their foliage several inches out of the water.

The length of time for which the typical submerged communities hold sway, varies considerably. Some examples, in small vleis, have been noted to yield place to the semi-aquatic communities in several years, but no difference in the condition of water-covered communities growing in larger bodies of water, has been noticeable in the space of three years. The production of higher stages is, of course, much delayed by damage done to the successional stages by severe droughts or floods.

The chief reaction of this stage is the formation of a raw litter or humus that in the course of time raises the level of the soil and adds body thereto, as well as adds slightly to its chemical constituents. Gradual improvement of the factors renders establishment of invading germules of the next stage possible. All gradations of invasion by this more advanced stage are found in any one water surface.

## (2) *The Stage of Floating Aquatics.*

The first representative of this stage, wherever the organs of attachment of the constituent plants are rooted in mud, ooze, and humus formed by the reaction of stage (I), is *Aponogeton distachyon*, which in time forms colonies, and later, consocieties; the latter may cover many square yards. *Nymphaea stellata* is another important plant, but is more frequent near the coast. It builds small consocieties, but may also occur in associates with *Aponogeton* and other species. In late summer its great blue flowers produce a fine effect. The extensive floating leaves of *Nymphaea* are responsible for the disappearance of portions of the stage of submerged hydrophytes—as the result of light interception.

Small colonies of *Lemna gibba* and *Wolffia arrhiza* are to be found along gently flowing streams; *Limnanthemum Thunbergianum* is very common, its small but abundant floating leaves covering the water for many yards.

*Utricularia exoleta* may occur in this stage.

The reactions of the floating hydrophytes are also in the direction of added humus and more stable soil conditions, but the rate of change is slow.

There are four possible successors to the above stage, and these will be described in turn, the most common first.

### (3a) *The Typha capensis Consocieties.*

*Typha capensis*, in river estuaries where the water varies from weakly saline to fresh, and in inland lakes and "vleis," as well as along river banks, forms luxuriant consocieties. The water may vary from several feet to several inches in depth; often the height of the *Typha* above the water is from three to five feet. The stage follows on that of the floating aquatics comparatively quickly; appreciable advance of the rushes is made in several years. *Nymphaea* and *Limnanthemum* for a time persist among the latter, but as the density of the rushes increased, the floating aquatics are ousted. Sometimes the floating aquatics may be omitted, the *Typha* following directly on the submerged aquatic stage.

The rushes gradually react upon the water surface to such an extent that in the densest parts of the community the investigator may walk without getting his feet more than damp. The dense mass of root and foliage presented by the community efficiently collects matter in suspension in the water, and this, together with the fall of *Typha* leaves and other debris, goes a long way toward converting the site from a free-water one to a silty, muddy one.

### 3 (b). *Phragmites communis Consocieties.*

The cosmopolitan grass, *Phragmites communis*, often follows on the floating aquatic stage, but may like *Typha capensis*, follow directly after the initial stage of submerged plants. *Phragmites* forms consocieties from six to eight feet in height above the water-level, as much as from two to three feet of the stems being below the surface. Although the reeds rapidly produce a dense community, they do not so readily build up a more stable substratum at their bases. Debris and matter in suspension are combed out, but to a lesser extent than in the *Typha* community. Very occasionally the exotic *Arundo donax* is found mixed with the *Phragmites*—Bews (1920: 397) records the same position in Natal.

### 3 (c). *Phragmites-Typha Associates.*

*Phragmites* and *Typha* are to be found in well-constituted associates of considerable extent. The origin of these communities is traceable to two distinct courses of events. In one instance, *Typha* and *Phragmites* happen to advance upon, and to colonize the same zone at the same time; they are species that do not react upon each other, and hence form within a short time

a strong associes. In the other instance, *Typha* forms an open community which is invaded by *Phragmites* before the *Typha* consociates has become too dense.

Considerable biotic interest centres in the formation of the reed and rush communities. Before their advent the water body supports little life, but when these species have built up a luxuriant zone, it is noticeable that bird life increases. The finches (weaver-birds) find their home in the reeds, and rear their young therein; the moor-hen seeks seclusion and forms colonies in among the rushes, while various species of duck, diver, teal, and snipe make their headquarters therein. Among mammals the Cape otter finds his lair in this vegetation.

### 3 (d). *Phragmites-Typha-Cyperaceae Stage.*

*Phragmites communis*, *Typha capensis*, and various *Cyperaceae* may be associated. Chief among the *Cyperaceae* found in such associes are the tall (eight-feet high) attenuated *Scirpus littoralis*, and the smaller, profusely developed *Fuirena hirta*, *F. Ecklonii*, and *Eleocharis limosa*. *Cyperus* sp. nov. (Schönland) standing several feet above the water, with much the same habit as *Scirpus littoralis*, also occurs in this stage. The *Cyperaceae* appear only in such places where the reeds and rushes are not over dense.

### 4. *The Stage of Semi-Aquatics.*

The stage of semi-aquatics may follow directly on that of the submerged aquatics, or on that of the floating aquatics, where the depth of water is insignificant throughout the year, or where seasonal fall of the water level results in the production of areas of sandy or silty alluvium, that bears little or no free water. The usual procedure, however, is for the stage to develop via one or other of the *Phragmites* and *Typha* communities already described.

The term "*semi-aquatic*" appears a vague one, but in reality it is preferable to any other that has occurred to the writer. It is employed in the same sense as that used by Bews (1920: 397), and is meant to include all light-demanding species which occur near to the margin of free-water surfaces; it is evident therefore that many species included in the category "*marsh-plants*" are embraced by the term. Certain light-demanding *macchia* and forest plants of locally wet or very damp soils, too, fall within the class. The typical plants of this stage are capable of undergoing without harm, periodic inundation; they are also able to suffer long-continued abundance of moisture around their roots; they thrive better in soils of high holdard than in those of medium or low.

The semi-aquatic zone is diagrammatically exterior to the *Phragmites* zone and immediately interior to the zone of large *Cyperaceae* later to be described. In Nature, however, its position in the zonation is liable to modifications: thus, it may be exterior to the *Cyperaceous* zone, or may border immediately on that of the floating aquatics. Successionally, however, it certainly does replace either the *Phragmites-Typha* zone or that of submerged aquatics. The reaction is in the direction of continued stabilization of the soil, and of its enrichment by the addition of organic and inorganic foods. Physically, the reaction is further reduction of ground water.

The plants of this zone are very numerous as to species, while the numbers of individuals, too, are large in the vicinity of extensive water bodies. The principal plants only will be listed:—

Smaller *Cyperaceae* are abundant as to numbers of individuals, the chief species being *Scirpus prolifer*, *S. rivularis*, *Fuirena hirta*, *F. Ecklonii*, *Pycurus polystachyus*, *P. umbrosus*, *Carex aethiopica*, *Cyperus tenellus*, *Juncellus laevigatus*, *Eleocharis limosa*; others are *Bulbostylis humilis*, *B. collina*, *Carpha capitellata*, *Costularia brevicaulis*, *Chrysithrix capensis*, *Ficinia acuminata*, *F. capillifolia*, *F. albicans*, *F. fascicularis*, *F. bracteata*, *F. bulbosa*, *F. gracilis*, *F. ixioides*, *F. dasystachys*, *F. tenuifolia*, *F. scariosa*, *F. secunda*, *F. ramossima*, *F. stolonifera*, *F. quinquangularis*, *F. striata*, *F. leiocarpa*, *F. sylvatica*, *F.*



trichodes, *Tetraria capillacea*, *T. pleiosticha*, *T. sylvatica*, *Scirpus capillifolius*, *S. membranaceus*, *S. Ludwigii*, *S. Hystrix*. *Scirpus prolifer* forms large and close consocieties, or is in association with *Juncus lomaphyllus*, *J. capensis*, or *J. oxycarpus*; *Ficinia capillifolia* rapidly dominates large areas, and the same is true of *Tetraria sylvatica*. *Pycreus polystachyus* and *Carex aethiopica* occur in mixture with *Mariscus congestus*; *Cyperus tenellus* often claims quite large areas. Associated with the Cyperaceae and Juncaceae are various other Monocotyledons and a fair number of Dicotyledons. Present on sites of this class are the grasses *Achneria ampla*, *Danthonia cineta*, *Imperata arundinacea*, *Leersia hexandra*, *Diplachne fusca*, *Stenotaphrum glabrum*, *Sporobolus pungens*, *S. indicus*, *Pennisetum Thunbergii*, *Polypogon monspeliensis*, *P. tenuis*, *Panicum maximum*, *P. proliferum*; these are always scattered and rather widely adaptable. They may occur in drier marshes and in moist macchia at later stages in the succession. Other plants represented are: Orchidaceae; species belonging to the genera *Aerolophia*, *Corycium*, *Eulophia*, *Disa*, *Bonatea*, *Disparis*, *Holothrix*, *Pterogodium*, *Penthea*, *Monademia*, *Satyrion*, *Schizodium*, *Liparis*, and *Habenaria*. Other Monocotyledons are *Zantedeschia aethiopica* (forms consociates many yards in area), *Romulea chloroleuca*, *R. rosea*, *Tritonia* spp., *Watsonia* spp., *Moraea* spp., *Caesia Thunbergii*, *Kniphofia alooides*, *K. tricolor*, *K. unicolor*, *Ianthe* spp., *Restiaceae* are not well developed, but species of the genera *Thamnochortus*, *Elegia*, *Restio*, *Dovea*, *Cannamois*, and *Leptocarpus* are present in small numbers.

Among Dicotyledons the more important parts are played by *Ranunculus pinnatus*, *R. plebius*, *Hydrocotyle asiatica*, *H. verticillata*, *Chironia maritima*, *Villarsia ovata*, *Lauremburgia repens*, *Gunnera perpensa*, *Drosera cuneifolia*, *D. capensis*, *C. cistiflora*, *Alechemilla capensis*, *Polygonum atraphaxoides*, *P. acuminatum*, *P. aviculare*, *P. senegalense* (exotic?), *P. serrulatum*, *Rumex acetosella* (exotic), *Samolus Valerandii*, *Sutera* spp., *Limosella aquatica*, *S. grandiflora*, the parasitic *Melasma capense*, and *M. sessiliflora*, *Zaluzianskya africana*, *Z. capensis*, *Z. maritima*, *Hyssanthus riparia*; the exotics *Veronica Anagallis*, *V. chamaedrys*, *V. serpyllifolia* occur occasionally near human habitations. *Cliffortia odorata* and *C. ferruginea* often form large consociates. In shady places *Impatiens capensis* is a common plant, forming rich consociates. *Anchusa riparia* is occasionally present, as are *Myosotis afra-palustris*, and *M. intermedia*; the exotic *M. sylvatica* grows near human habitations. Campanulaceae are represented by *Wahlenbergia procumbens*, *W. stellaroides*, *W. undulata*, *Lobelia patula*, *L. tomentosa*, *L. pubescens*, *L. repens*, *L. villosa*, *L. hirsuta*, *L. coronopifolia*, *L. anceps*, *L. linearis*. Sometimes *Silene bellidioides*, *S. capense*, and the exotics *Spergula arvensis*, *Spergularia media*, *S. rubra*, and *Stellaria media* are present. Compositae favouring the moist zones are *Bidens pilosa*, *Cotula coronopifolia*, *Cryptostemma calendulaceum*, *Diehrocephala latifolia*, *Gerbera cordata*, *Hippia frutescens*, *Matricaria* spp., *Senecio* spp., *Sonchus oleraceus* (exotic), *Ursinia* spp.,

Among the Crucifers are *Cardamine africana* and *Heliophila* spp. *Geraniaceae* show *Geranium ornithopodium*, *G. incanum*, *G. canescens*, and *Pelargonium* spp. *Guttiferae* are sparse—*Hypericum aethiopicum*, *H. Lalandi*. *Labiatae* are not very abundant—*Leonotis leonurus*, *Mentha aquatica*, *M. longifolia*, *M. viridis*, *Plectranthus* spp., *Stachys aethiopica*, *Teucrium africanum*, *T. capense*. *Leguminosae* are scanty—*Indigofera* spp., *Lessertia* spp., and *Loddigesia oxalidifolia*, and several *Psoraleae* being the only representatives of any importance. The exotic *Trifolium repens* is common in places. *Lythrum hyssopifolium* is the only member of the *Lythraceae*\*. Finally, *Oxalis* spp., *Galopina circaeoides*, *Valeriana capensis*, *Verbena bonariensis* (exotic) are common.

\* Exotic.

### 5. *The Stage of Tall Cyperaceae.*

Reference to the schematic chart (2) of the hydrosereal succession will show the relationship of the stage of tall Cyperaceae to those stages that have already received description. Features of importance are that the Cyperaceous stage may follow directly after the floating aquatics, or may proceed via the semi-aquatic stage, and that the succession may follow on from the Phragmites-Typha stage direct, or may proceed from that stage to the semi-aquatic stage, and then to the stage under discussion. The various modifications that exist in the succession have made the study of the process less easy than was at first expected.

The stage of tall Cyperaceae is a well-defined one, very well represented along most of the larger rivers and "vleis." Judging from Bews's (1920 : 398) description of the hydrosereal succession on the coast-belt of Natal, his *Cyperus-Mariscus* stage is the equivalent of the stage of tall Cyperaceae at the Knysna.

The stage is made up of tall-growing (six-eight feet high) Sedges of the species listed below :—

*Mariscus riparius*, *Mariscus congestus*, *Cyperus immensus*, *Cyperus textilis*, *Cladium jamaciense*, *Carpha glomerata*, *Scirpus littoralis*, and usually some of the smaller Cyperaceae: *Eleocharis limosa*, *Fuirena* spp., *Pycreus polystachyus*, *Carex aethiopica* and others.

The general reactions of the community are to add more body to the soil and to reduce the light-intensity on the floor to such a point that the less-assertive species of the invaded semi-aquatic stage are ousted. At the same time, a few of the species of the latter stage, notably certain of the smaller Cyperaceae, certain Orchids and *Cliffortia* spp. do manage to survive in association with the tall Sedges.

*Juncusomatophyllus* and *J. oxycarpus* manage to grow along the outer limits of the Sedges. Near the ocean, *Juncus maritimus* and *J. acutus* may form extensive communities immediately exterior to the tall Cyperaceae.

Two courses are now open: The Sedge stage may give way to that of *Hygrophilous Macchia* direct, or, as is often the case, may yield place to that of the "Palmiet," *Pronium palmita*.

### 6. *The Pronium palmita* or "Palmiet" Stage.

The peculiar, woody-stemmed Juncaceous plant *Pronium palmita* is widespread in the region. The formation of communities of this species is a relatively slow process, the growth per annum of the *Pronium* being little, hence the development of *Hygrophilous Macchia* directly from either the Phragmites-Typha or the semi-aquatic communities must expedite the building up of this type of vegetation very considerably.

The endemic monotype produces stems varying in length from three to six feet, with diameters of from one to two inches; the leaves form a dense apical rosette, the diameter of which may be as much as three feet. *Pronium* is abundant along river banks; when burned the stems rapidly produce fresh shoots.

### 7. *Hygrophilous Macchia.*

The *Hygrophilous Macchia* is a most important stage in the development of the hydrosere; so far as has been ascertained, all the later seral stages have their true origin in this community, and cannot develop direct from the lower *Pronium*, Cyperaceous, Semi-aquatic, Phragmites-Typha stages. Reference to the schematic chart (2) reveals that the *Hygrophilous Macchia* itself may arise in several distinct manners. Firstly, it may develop direct from the Phragmites-Typha stages, when the water-level is insignificant, or when locally drier areas exist within these stages. A second course is for it to follow on *Pronium palmita*. Lastly, the stage of semi-aquatics may directly yield place to it.

*Hygrophilous Macchia* is well developed along river beds, and moist valleys, on the lower, cool southern slopes of such valleys, and in the vicinity of large "vleis," and on local flushes. It also occurs along seepage lines on drier areas. According to locality the community shows much floristic as well as sociological variation; the number of dominants on any one area may vary from several to over a score; the height, too, may vary from several to ten feet. The density of the stands is naturally a feature of the particular dominants and sub-dominants present, but generally this may be described as being very close.

The stage is instrumental in bringing about many important changes in the soil, and at the same time introduces fresh biotic associates. In its taller portions it greatly influences the atmospheric factors.

So far as prime soil reactions are concerned, we find that reduction of holarid, increase of chresard, decrease of soil acidity, improved physical conditions—depth, porosity—are brought about. Biotic changes involved are the increase in numbers of soil micro-organisms, the advent of earthworms in small numbers, the coming in of rodents (mice, voles, and hares), of small buck (*Grijsbok*, *Bluebuck*). Birds are abundant, including the doves and Cape partridges. Insect life as well as reptilian (lizards, snakes, rarely tortoise) shows a remarkable increase. Climatic changes are in the direction of slightly increased humidity of the air, greatly decreased air temperature, greatly decreased rate of evaporation, and reduced light-intensities—the relative humidity several feet above the ground, during the warm hours of the day may be increased from 60 to 80 per cent., the air temperature at the same level may be reduced from 85 to 65° F., the evaporation rate may fall from 30 c.c. per twenty-four hours to 15 c.c., while the light-intensity may show reduction from 1 to 1/50–1/100. A steady amelioration of the factor-complex is thus in operation; acting, as it does, over very lengthy periods of time, the *Hygrophilous Macchia* is in reality responsible for the conversion of extreme edaphic and climatic factors to ones less extreme.

The principal species and communities forming the stage are listed below. It is necessary, however, to point out that certain of the species are adaptable to somewhat drier conditions.

Neglecting sociological details, the species present are:—*Thamnochortus argenteus*, *T. erectus*, *T. fruticosus*, *Elegia parviflora*, *E. equisetacea*, *E. asperiflora*, *E. spathacea*, *E. thyrsoiflora*, *E. thyrsoidea*, *E. verticillaris*, *Hypodiscus albo-aristatus*, *H. striatus*, *H. ramosus*, *H. spp.*, *Leptocarpus paniculatus*, *Willdenovia teres*, *Restio comosus*, *Restio MacOwani*, *R. giganteus*, *R. triticeus*, *R. compressus*, *R. spp.*, among the *Restiaceae*. Grasses are scattered, and are mostly of the same species as listed under "semi-aquatics," belonging to the genera *Achneria*, *Danthonia*, *Imperata*, *Leersia*, *Diplachne*, *Stenotaphrum*, *Pennisetum*, *Polypogon*, and *Panicum*. *Cyperaceae* are to some extent represented—principally by *Tetraria spp.* (*T. capillacea*, *T. involuerata*, *T. robusta*, *T. secans*), *Ficinia spp.* (e.g., *F. capillifolia*, *F. leiocarpa*, *F. sylvatica*), but with the exception of *Ficinia capillifolia* and *Tetraria sylvatica*, which form dense layer societies in certain places, these are of little sociological importance. *Mariscus congestus* and *Carex aethiopica* are common, but scattered. The orchids are abundant as to species, but also play a subordinate role sociologically; present are *Liparis capensis*, *Holothrix villosa*, *H. pilosa*, *H. spp.*, *Habenaria Dregeana*, *H. MacOwaniana*, *Eulophia aculeata*, *E. rupestris*, *E. tabularis*, *Disperis capensis*, *D. paludosa*, *D. disaeformis*, *Disa polygonoides*, *D. tripetaloides*, *D. glandulosa*, *D. cylindrica*, *D. cornuta*, *D. racemosa*, *D. spp.*, *Pterogodium Newdigatae*, *P. acutifolium*, *Satyrinum acuminatum*, *S. bicornis*, *S. outeniquense*, *S. Penterianum*, *S. foliosum*, *S. erectum*, *S. candidum*, *S. ligulatum*, *S. spp.*, *Monadenia micrantha*, *M. auriculata*, *Acrolophia micrantha*, *A. tristis*, *A. cochlearis*, *Bartholina Ethelae*, *Bonatea speciosa*, *Corycium nigrescens*, *C. carnosum*, and species of *Ceratandra*, *Brown-*

eca, *Hersehelia*, *Forficaria*, *Penthea*, *Platanthera*, and *Ceratandropsis*. Iridaceae show *Gladiolus Bolusii* var. *Burehellii*, *G. spathaceus*, *G. pulchellus*, *G. maculatus*, *G. spp.*, *Romulea spp.*, *Homeria collina*, *Moraea ramosa*, *M. trieuspsis*, *Tritonia lineata*, *T. spp.*, *Watsonia spp.*, *Ixia polystachya*, *I. spp.*, *Geissorhiza spp.* Among the Liliaceae are *Caesia Thunbergii*, *Bulbine spp.*, *Bulbinella spp.*, *Eriospermum spp.*, *Tulbaghia spp.*, *Kniphofia spp.*, *Ornithogalum spp.* Other Monocotyledons of importance are *Juncusomatophyllus*, *J. capensis*, *J. oxycarpus*, *Cyanotis nodiflora*, and *Zantedeschia aethiopia*.

Dicotyledons are very numerous floristically and individually ; important plants are :—*Berzelia lanuginosa*, *B. intermedia*, *B. commutata*, *B. abrotanoides*, *Brunia nodiflora*, *B. cordata*, *Pseudobaeckea racemosa*, *Nebelia palacea* of the Bruniaceae ; *Cluytia pulchella*, *C. affinis*, *C. alaternoides*, *C. spp.*, *Adenodine spp.* of the Euphorbiaceae ; the Gentianaceae provide *Chironia melampyrifolia*, *C. linoides*, *C. peduncularis*, *C. spp.*, *Sebaea spp.* ; Geraniaceae are frequent—several species of *Geranium* and over a dozen species of *Pelargonium* ; *Gunnera perpensa* and *Laurembergia repens* of the Halorrhagaecae are abundant in open places ; Labiatae have *Plectranthus spp.* ; *Stachys spp.* ; *Salvia spp.* ; *Teucrium spp.* ; the parasitic Lauraceous *Cassytha ciliolata* may form untidy masses on the branches of various shrubs ; Leguminosae are abundant in species and in individuals—*Aspalathus spp.* ; *Crotalaria capensis*, *C. obscura*, *C. purpurea*, *Argyrolobium spp.* ; *Indigofera flabellata*, *I. procumbens*, *I. hispida*, *I. heterophylla*, *I. candicans*, *I. Zeyheri*, *I. ovata*, *I. coriacea*, *I. spp.* ; *Loddigesia oxalidifolia* ; *Podalyria calyptata*, *P. cuneifolia*, *P. sericea*, *P. myrtifolia* ; *Psoralea pinnata*, *P. axillaris*, *P. bracteata*, *P. carnea*, *P. decumbens*, *P. repens*, *P. tomentosa*, *P. restioides*, *P. spp.* ; *Priestleya augustifolia*, *P. myrtifolia* ; species of *Rhynchosia*, *Vigna*, *Tephrosia*, *Lotonotus* ; *Sutherlandia frutescens* ; Malvaceae are not abundant—species of *Malvastrum* and *Pavonia*, and *Sida triloba* ; *Myrica conifera* represents the Myricaceae, and *Myrsine africana* the Myrsinaceae. Polygalaceae have *Polygala oppositifolia*, *P. myrtifolia*, *P. pinifolia*, *P. virgata*, *P. hispida*, *P. bracteolata*, and sometimes species of *Murraltia* ; Proteaceae apart from *Leucadendron adscendens*, *Mimetes palustris*, *M. hirta*, *M. pauciflora* do not occur abundantly at this stage ; Rosaceae contain some important plants—*Cliffortia ferruginea*, *C. odorata*, *C. linearifolia*, *C. juniperina*, *C. sarmentosa*, *C. strobilifera*, *C. graminea*, the exotic *Rubus fruticosus* is widespread, and in places *R. rigidus* and *R. pinnatus* are frequent ; *Alchemilla capensis* occurs in opener places. There are few Rubiaceae—*Galium asperum*, *G. glabrum*, *Galopina circaeoides*, *Anthospermum spp.* ; Rutaceae are very abundant—*Agathosma ciliata*, *A. erecta*, *A. hirta*, *A. blaeroides*, *A. apiculata*, *A. serpyllacea*, *A. platypetala*, *A. pubescens*, *A. microphyllus*, *A. spp.*, *Barosma lanceolata*, *B. ovata*, *B. scoparia*, *B. venusta* ; *Diosma vulgaris*, *D. ramossima* ; *Empleurum serrulatum*—some of these are of importance sociologically. *Grubbia rosmarinifolia* is a common Santalaceous plant, while the semi-parasitic *Thesium spp.* (about twenty-five), too, are present ; of Serophulariaceae there are *Sutera affinis*, *S. microphylla*, *S. pinnatifida*, *S. stenophylla*, *S. cordata*, *S. brachiata*, *S. foetida*, *S. spp.* ; the semi-parasitic *Harveya capensis*, *H. hyobancheoides*, *H. tribulosa*, *H. purpurea*, *H. speciosa*, and *Hyobanche sanguinea* ; *Limosella aquatica* occurs in damp places ; common are *Melasma sessiliflorum*, *M. scabrum*, *M. luridum*, *M. capense* ; *Nemesia divergens*, *N. foetens*, *N. spp.* ; *Zaluzianskya spp.* ; *Diclis reptans* also occur. Selaginaceae show several spp. of *Selago* and *Hebenstreitia*. *Hermannia hyssopifolia*, *H. linifolia*, *H. spp.* are the only plants in the Sterculiaceae. Thymeleaceae have *Gnidia oppositifolia*, *G. denudata*, *G. nodiflora*, *G. orbiculata*, *G. seabrida*, *G. spp.* ; *Struthiola argentea*, *G. hirsuta*, *G. striata*, *G. spp.* ; *Lasiophyon spp.* Umbellifers present are *Bubon capense*, *B. tenuifolium*, *B. hypoleucum*, *Foeniculum officinale*, *Hydrocotyle debilis*, *H. eriantha*, *Lichten-*

steinia spp.; *Peucedanum capense*, *P. capillaceum*, *P. ferulaceum*, *P. sium* *Thunbergii*, *Hermas ciliata*, and the variable *Heteromorpha arborescens*. *Valeriana capensis* is the only member of the Valerianaceae. The exotic *Verbena bonariensis* is locally abundant in many places. The Convolvulaceae are represented by the parasitic *Cuscuta africana*, *C. cassytoides*, and *C. appendiculata*. Among Asclepiads are the poisonous *Cynanchum africanum*, *C. capense*, and *C. obtusifolium*; *Asclepias fruticosa* is locally abundant. The Campanulaceae present are chiefly species of *Lobelia*—*L. anceps*, *L. repens*, *L. spartioides*, *L. pubescens*, *L. linearis*, *L. hirsuta*, *L. villosa*, *L. tomentosa*, and *L. coronopifolia*; *Wahlenbergia procumbens*, *W. undulata*, *W. stellaroides* also occur. The principal Compositae are—*Helichrysum felinum*, *H. foetidum*, *U. umbraculigerum*, *H. ericaefolium*, *H. petiolatum*, *H. odoratissimum*, *H. serpillifolium*, *H. capitellatum*, *H. appendiculatum*, *H. parviflorum*, *H. spp.*; *Senecio rigidus*, *S. lineatus*, *S. glastifolius*, *L. lyratus*, *L. crenatus*, *S. rosmarinifolius*, *S. spp.*; *Stoebe cinerea*, *S. alopecuroides*, *Ursinia anthemoides*, *U. subhirsuta*; *Hippia frutescens*, *H. pilosa*, *Pulicaria capensis*, *Peyrousea calycina*, *Pteronia spp.*; *Matricaria spp.*; *Leontonyx squarrosus*, *Osmites bellidiastrum*, *Helipterum eximium*, *H. canescens*, *Metalasia muricata*, *Athrixia capensis*, *Euryops abrotanifolius*, *Osteospermum coriaceum*, *Bidens pilosa*. Species of *Heliophila* are the sole Crucifers. *Drosera capensis*, *D. cuneifolia*, and *D. cistiflora* are all the Droseraceae. The Ericaceae are very numerous as to species and also play an important part sociologically—*Erica canaliculata*, *E. curviflora*, *E. cerinthoides*, *E. densifolia*, *E. copiosa*, *E. inconstans*, *E. formosa*, *E. gibbosa*, *E. seriphifolia*, *E. discolor*, *E. viridiflora*, *E. scabriuscula*, *E. pectinifolia*, *E. astroites*, *E. tetragona*, *E. caffra*, *E. deliciosa*, *E. tenella*, *E. gracilis*, *E. glomiflora*, *E. quadrangularis*, *E. hispidula*, *E. arachnoides*, *E. leucopeltata*, *E. lanata*, *E. adunca*, *E. Nabea*, *E. floribunda*, *E. cubica*, *E. melanthera*. *Blaeria fuscescens*, *Simocheilus multiflorus*, *Salaxis puberula*.

Among ferns are *Pteris aqualina* (*Pteridium aquilinum*), *Blechnum punctulatum*, *B. tabulare*, *Pellaea quadripinnata*, *P. viridis*, *Gleichenia polypodioides*, *Todea barbara*, *Polystichum pungens*. The Lycopods *Lycopodium carolinianum*, *L. cernuum* are occasionally found. Mosses and hepatics are not common.

These and other species are associated in various ways, the study of the various sociies, consociies, and associies being a work in itself. No attempt will be made to list the very numerous communities that do occur, only the general stages of greater importance will be dealt with briefly:—

- (1) Restiaceae are often pioneers of the stage—*Thamnochortus*, *Dovea*, and *Restio* particularly.
- (2) Simultaneous with these, or shortly after them, appear the hygrophilous *Cliffortia* spp.—*C. ferruginea*, *C. odorata*, *C. linearifolia*, *C. sarmentosa*, *C. strobilifera*, *C. graminea*, *C. juniperina*—these build up associies with the Restiaceae, or else gradually onst the latter.
- (3) The Bruniaceae, more especially *Berzelia* spp.; *Brunia nodiflora* follow, and associate with the Cliffortias, or may form such communities as the *Berzelia intermedia* consociies, the *Brunia nodiflora* consociies, and the *Berzelia* spp. associies.
- (4) Following the Bruniaceae are such plants as *Erica canaliculata*, *E. curviflora*, *E. densifolia*, *E. gibbosa*, *E. inconstans*, which mingle with the *Berzelia*, *Brunia*, and *Cliffortia*, and in time form associies with them. Other species that may come in at this stage are the large *Barosma scoparia*, the tall "Berg Buchu," *Empleurum serrulatum*, *Grubbia rosmarinifolia*; *Psoralea pinnata*, *P. spp.*; *Podalyria calypttrata*, *Crotalaria* spp.; *Cyclopia brachypoda*, *C. subternata*, *Cluytia affinis*, *C. alaternoides*, *Polygala myrtifolia*, and many others.

These species continue to form associates one with the other, or to form pure consocieties—thus a community rich in species and showing considerable variation sociologically, is built up.

- (5) Proteaceae enter after the foregoing, forming luxuriant communities attaining eight to fifteen feet in height. The principal spp. are :—*Protea cynaroides*, *P. laticolor*, *P. neriifolia*, *P. Mundtii*, *P. longiflora*; *Leucadendron plumosum*, *L. salignum*, *L. uliginosum*; *Leucospermum conocarpum*, *L. glabrum*; *Mimetes hirta*, *M. pauciflora*, and *Aulax pinifolia*.
- (6) Many species of the semi-aquatic stage persist as subdominants, in small ground socies, chief among these being the grasses, the Cyperaceae, the Orchidaceae, the Iridaceae, and the Liliaceae, various small Scrophulariaceae, Campanulaceae, Compositae, Droseraceae, Geraniaceae, Gentianaceae, Oxalidaceae, Rubiaceae, and Umbelliferae.

From the Hygrophilous *Macchia* development may proceed along several different lines. The *macchia* may remain climax, or may develop to scrub, this latter community being succeeded in due course by bush, and the sere terminated by forest of moist type. On the other hand, the *Virgilia capensis* consocieties may follow the *macchia* and ultimately usher in bush, the latter developing into forest with time. Finally, *macchia* may yield place to the hygrophilous small tree stage, forerunner of either bush or the *Platylophus* communities.

Stages developed from Hygrophilous *Macchia*, but not in the direct sequence, are the *Salix-Empleurum* associates and the *Strelitzia angusta* consocieties, the relationships of which are shown in the schematic chart.

These last-named stages are described below :—

#### 8. *Salix capensis-Empleurum serrulatum* Associates.

Along several rivers *Salix capensis* Thunb. var. *mucronata* And., forms small associates with *Empleurum serrulatum*. The associates usually attain heights varying from ten to twenty feet, and is fairly open, the *Salix* throwing light shade and the *Empleurum* not possessing a heavy canopy.

The *Salix* is deciduous in winter. Associated with the dominants are various subdominants :—the shrubby *Freylinia undulata*, *Cliffortia strobilifera*, *C. juniperina*, *Psoralea pinnata*, *Podalyria calyptrata*, *Cluytia pulchella*, *Phyllaea racemosa*, *Rhamnus prinoides*, *Polygala myrtifolia*. Such minor plants as *Scirpus prolifer*, *Juncus lomatosphyllus*, *Zantedeschia aethiopica*, *Hydrocotyle asiatica*, *Laurembergia repens*, and *Galopina circaeoides* may occur on the ground. The associates seems to remain in existence for considerable periods but ultimately develops into the river valley forest scrub later described.

#### 9. *Strelitzia angusta* Consocieties.

The giant *Strelitzia angusta* or "Wild Banana" forms consocieties varying in height from ten to twenty feet. The simple stems of the *Strelitzia* are usually from six to twelve inches in girth at their bases, and bear giant leaves (from three to eight feet in length by one and a half to two and a half feet in width) towards their apices. The stocking is usually fairly dense, the foliage allowing little light to reach the ground. Considerable litter is added to the soil by the casting of the leaves and the frequent fall of stems. The rhizomes are not deeply placed, and the plants despite the splitting of their leaves parallel with the veins, are readily thrown by wind.

The plants produce flowers with white sepals and petals, and fruits with bright-coloured, hairy arils. The flowers are pollinated by the honey bee and by sunbirds (*Nectariniidae*). The seeds are borne by birds, but apparently are not eaten by them, the coloured arils acting as misleading attractions.

Associated with the opener consocieties are sometimes subordinate spp., such as *Zantedeschia aethiopica*, *Eulophia* spp.; *Acrolophia* spp.; *Disa* spp.; *Bonatea speciosa*, *Kniphofia* spp.; *Romulea*, spp.; small *Cyperaceae*, and some herbaceous *Dicotyledons*.

According to Bews (1920: 415), *Strelitzia* in Natal follows "Umdoni," *Eugenia cordata*; at the Knysna the species comes in after establishment of the *Hygrophilous* *Macchia*. On the death of many of the plants—due either to old age or to wind—the consocieties allows of the entry of such species as *Sparmannia africana*, *Polygala myrtifolia*, *Osteospermum moniliferum*, *Rhamnus prinoides*, *Protea* spp., *Leucadendron eucalyptifolium*, *L. salignum*, and *Burchellia capensis*, the true fore-runners of the medial forest stages. Shading of the *Strelitzia* slowly brings about loss of vigour, and the ultimate subjugation or destruction of the species in the community. *Strelitzia* is only occasionally found west of the Keurbooms River\*.

#### THE HALOSERE.

Areas.—Salt or brackish silt and sand flats and banks at the estuaries of rivers, these flats being in portions inundated twice daily, in others, at Spring or other exceptionally high tides only.

Silt and sand flats are extensively developed in the estuaries of the Knysna and Keurbooms rivers,† and bear a characteristic vegetation the principal features of which are described below.

The plant covering is poor in species, and in many portions, open in nature, being thus in keeping with the statement of Warming (1909: 218), that two features common to halophytic communities are *the exceeding poverty of the flora and the very open nature of the vegetation*.

In the Knysna and Keurbooms estuaries the gypsum derived from the Enon beds in the vicinity is acted upon by the common salt in the sea water, and produces sodium sulphate, which is innocuous to plants. Accordingly when higher portions of the silt and sand flats are suitably treated and irrigated, they serve for the growing of field crops of very fair quality. Those flats that are frequently inundated, of course, are useless for this purpose. In such places where gypsum does not occur but where Aeolian drift does, the sodium chloride is neutralized by the calcium carbonate in the sand. Portions possessing no gypsum and receiving no sand, remain strongly saline, and if frequently inundated, carry little or no vegetation, the surface of the ground lying practically bare.

The chief communities are:—

##### 1. *Zostera marina* var. *angustifolia* Consocieties.

The dark-green long-leaved grass wrack occurs in the innermost zone with respect to the salt water bodies. Its extensive consocieties gradually build up banks of clay and fine silt—the *Zostereta* of Warming (1909: 230). In the course of time these banks are raised still higher, until they allow of the entry of *Salicornia natalensis* and of *Cyanophyceae*.

In many places the *Zostera* is submerged at high tides, but to some extent exposed to the atmosphere at low. In others, the plant is always submerged.

That *Zostera* has a marked influence in the building up of banks and of meadows within a comparatively short time is evident from comparison of the charts of Knysna Harbour of 108 years ago‡ with those of to-day. Neglecting

\* The Western Limit is at Harkerville Forest (Muller's Hoek)—*vide* Diagram XXIX.

† *Vide* Maps.

‡ Surveyed by William Walker, R.N., 1818. Shown me by the late John Rex, Esquire, of Knysna, 1923. A copy is in the Clubroom of the Knysna Yacht Club.

disturbances caused by man, it is seen that quite extensive raised areas bearing *Zostera* and *Salicornia* exist to-day, where there was open water 108 years ago.

## 2. *Salicornia natalensis*.

The Marsh Samphire reacts upon the mud banks and flats colonized by *zostera*, so that these are steadily raised. As the period of exposure to the atmosphere increases, so does dominance of *Zostera* decrease.

Eventually *Salicornia* entirely ousts *Sostera* and forms consocieties—the *Salicornieta* of Warming (1909 : 230).

Reference to the 108-year-old chart of the estuary of the Knysna reveals that portions submerged at high tides, and then bearing *Salicornia natalensis*, to-day are raised fields bearing *Juncus maritimus*, or field crops.

## 3. *Chenolea diffusa*.

The *Salicornia* consocieties in time is invaded by *Chenolea diffusa*, which either forms smaller consocieties within the former, or else mingles with it throughout the area and thus producing a *Salicornia-Chenolea* *associetis*. These species continue to collect silt, and in this way to raise the level of the flats. *Cyanophyceae* are still frequent at this stage.

4. *Mixed communities* of *Salicornia natalensis*, *Chenolea diffusa*, *Triglochin striatum*, *Seripus littoralis*, *Laurembergia repens*, *Cotula coronopifolia*, and *Juncus maritimus* form the next stage. The level is higher and the soil drier than in the *Salicornia-Chenolea* *associetis*.

*Juncus maritimus* often forms large consocieties in the drier portions.

5. *Sporobolus pungens*, *Cynodon dactylon*, *Stenotaphrum glabrum*, and *Juncus maritimus* are the principal species of the zone exterior to the mixed community above-mentioned. The soil rarely receives salt water, and is much less moist and considerably less saline, than that of the mixed community. *Samolus porosus*, *S. Valerandii*, *Aster ficoideus* and *Frankenia capitata* may grow along with the grass and rush dominants.

6. The succession on silty portions passes to the stage of Semi-aquatics of the Hydrosere, and from this to climax *maecchia* of stunted nature.

On sandy areas it develops *Psammophilous Macchia*, which in turn gives place to *Psammophilous Scrub* and *Psammophilous Bush*. This is an interesting example of initial stages of one sere at a certain point bifurcating\* so that essentially different types of *elimaxes* are produced.

## THE PSAMMOSERE.

Areas.—Sandy beaches, littoral dunes, sandy river beds, and in past ages sandy plateaux and basins.

The pioneer stages of the psammosere establish themselves on unstable, sandy surfaces, and by processes of sand-fixation, addition of organic and inorganic foods, and increase in moisture-content of the substratum, gradually bind together and enrich these surfaces.

In the region under study there is at the present day no very great development of the *earliest priseral* stages of the psammosere. Sandy beaches and duneland present the most extensive areas bearing these stages: along the beds of most of the rivers and streams examples of the psammosere in its earliest stages are numerous, but the communities are of very limited extent. The areas available for development of the psammosere, in past ages must have been fairly large. Extensive portions along the strand proper and upon the first plateau probably were bare sandy wastes during very late Tertiary

\* *Vide* Schematic Chart (Diagram XIV).



and early Recent Times—on these there are to-day semi-climax bush, sub-climax scrub, sub-climax bush, climax forest of coastal type, and Psammophilous Macchia. The white sands of the Knysna Series, lying on the first plateau and reaching portion of the second, to-day bear climax forest of very fair quality.

While the various stages described in the following account do occur in definite zonation in many instances, it is necessary to point out that in others there are various modifications introduced by changes in nature of locality, type of vegetation adjacent, supply of germules, and zoo-biotic associates.

For sake of clearness the psammosere developing on sands near the ocean will be treated separately from that developing along river valleys or elsewhere, inland. Several of the pioneer stages have much in common no matter where they be developed, but the ultimate stages, although distinctly related in certain respects, are widely different in others.

The succession on the coast will be described first:—

#### 1. *Pioneers on periodically-tide-washed beach.*

Portions of the lower beach above high water mark are wave-washed during Spring or other exceptionally high tides: such tides occur about from six to 12 times per annum. The beach may rise slightly as it proceeds inland, or may be flat. The winds pass too high above this portion of the beach to produce much drifting of the sand. The occasional high tides mentioned, together with spray borne inland from the breakers, assist in keeping the sand slightly damp at less than one inch below the surface.

Pioneer plants colonize portions of this zone:—

##### (a) *Salicornia fruticosa* var. *densifolia*.

This succulent xerophyte forms open consocieties of small area. The plant attains an average height of twelve inches, and forms gnarled, woody branches of great strength. It shows no ill-effects after being inundated by sea water. *Salicornia* is a fairly efficient sand-fixer, but forms local hummocks that are swept away by very strong tides or by severe sea winds.

##### (b) *Sporobolus pungens*.

This wiry grass so widely distributed along the coast of South Africa and of other warm lands, is an important plant in this zone.

The creeping rhizomes are stoloniferous, and within a short time materially increase the area of the consocieties, as well as decrease their openness. Eventually it produces hard, raised mounds, which resist the strongest tides and winds. Like *Salicornia fruticosa*, *Sporobolus pungens* is not sensitive to sea water: consocieties have been noted to grow in situations inundated several times per week, and yet to remain healthy and to extend their limits.

##### (c) *Scaevola Thunbergii* E. & Z. (*S. lobelia* Murr.).

This fleshy-leafed plant with its strong, abundantly-developed rhizomes, is a common pioneer in this zone. Regeneration is from seed, or vegetatively. Seedlings are often lesioned at the collars, should they be produced during warm, dry weather when the sand has been raised to temperatures of from 160–180 deg. Fahr. at its surface. During cooler weather the young plants readily establish themselves, and grow fast despite being half covered by sand. The *Scaevola* consocieties are often many square yards in extent; they form large hummocks, which at times are washed away by very high tides.

The plant is an excellent sand-fixer, and would be of great utility in drift-sand work were it not for its habit of hummock formation—these hummocks are scoured by the wind, and form weak spots in the artificial “littoral dune.”

*Sporobolus pungens* and *Hydrophylax carnosa* sometimes associate with the *Scaevola*.

(d) *Hydrophylax carnosa*.

This procumbent, fleshy rubiaceous plant is abundant in certain portions of the coast, but is entirely absent from others. It forms very small, open consocieties, and may, as above-mentioned, enter open communities of *Scaevola* and *Sporobolus*, in which it plays the role of a sub-dominant.

During exceedingly high seas much sand is tossed up, and the pioneer plants may either be torn from their situations or may be covered from several inches to as many feet in sand. Buried communities do not always succumb, for *Scaevola* and *Sporobolus* have really remarkable capacity for lying covered but visible for long periods; the ever-blowing sea breezes within several weeks usually uncover the buried plants.

Emphasis must be laid upon the extreme nature of this initial sandy habitat—severe insolation, strong and almost continually blowing winds, an atmosphere charged with salt, a substratum of innutritious sand often strongly saline, severe surface soil temperatures on clear, warm days throughout the year, and periodic drought in the upper layers. Such plants as *Salicornia fruticosa*, *Sporobolus pungens*, and *Scaevola Thunbergii* have well worked out the problem of capture and conversion of so extreme a habitat.

The periodically-tide-washed beach gradually yields way to that portion of the lower beach that never experiences salt water inundation, and this latter, to the upper beach and dunes.

2. *The Upper Beach and Sand Dunes.*

The upper beach and dunes are composed of dry sand much of which is kept in motion by sea and land breezes. The upper beach being considerably lower (from 10 to 30 feet elevation) than the dunes proper (from 50 to 200 feet), does not experience nearly as much wind as the latter.

While there is a general movement of the dunes inland, owing to the prevalence of the sea winds, there are minor movements in all directions owing to local wind currents and eddies. The steeper slopes of the dunes are to leeward, and despite the considerably less rough climatic conditions these slopes experience, often show smaller plant populations than do the windward slopes. The reasons for this are several: firstly, plants are better able to establish themselves and to spread on slopes of less intensity; secondly, there is a continual slipping downward of sand from above, on the leeward slopes, burying such pioneers as may have established themselves, wholly or in part; thirdly, it is often found that the moisture-content of the sand at levels of from six to twelve inches on the windward slopes is greater than that at equivalent depths on the leeward, the differences being more marked if the latter experience northern or north-western aspects. Pioneer communities, however, are found in greatest numbers and in the most luxuriant condition in the hollows at the bases of the dunes on their leeward sides. Such hollows enjoy better soil-moisture conditions—through seepage from the dunes—and better protection from wind and insolation than do any other portions of the upper beach and younger dunes. Owing to the scouring action of the local breezes and of the stronger land winds, such hollows are gradually increased in extent, and are colonized by pioneer plants as they extend.

From such centres of plant life there advance colonizing forces that invade the steep lee slopes of the dunes and slowly but surely capture ground. Unless the dune in question happens to be particularly unstable, the gradual fall of sand from above is not sufficient to inhibit the establishment and growth of the more assertive members of the invading pioneers. Such species as *Cryptostemma niveum*, *Ficinia lateralis*, *Eragrostis cyperoides*, *E. glabrata*, *Mariscus congestus*, *Stenotaphrum glabrum*, *Mesembryanthemum edule*, *Tetragonia decumbens*, *Solanum aggerum*, *S. nigrum* (sea form), *Scaevola*

*Thunbergii*, and *Myrica cordifolia*, are persistent invaders. At a later stage *Cussonia thyrsiflora*, *Stoebe cinerea*, *Rhus crenata*, *Restio Eleocharis Ericephalus umbellatus*, *E. capitellatus*, *Salvia aurea*, *Sutherlandia frutescens*, and *Passerina rigida*, are frequently found as invaders.

Very unstable dunes, however, allow of no colonization of their slopes, and advance upon any hollows that may occur at their bases, thus killing out the few pioneers that may have established themselves.

Through disturbance caused by man and his animals there is a tendency for the dunes in certain localities to advance upon the macchia and scrub inland, and to destroy pasture and arable land.

The introduction by the Forest Department of a modification of the famous Bremontier\* system of dune-fixation, at Buffalo Bay is already producing good results. The exotic Marram (*Ammophila arundinacea*)† has been planted at the Bay and also on Knysna Western Head as well as at the Zitzikanima drift sands, with the result that the plant is spreading naturally. Certain indigenous psammophytes and macchia plants are being employed with promising results.

The principal features of the vegetation of the upper beach and dunes are described below.

The periodically-tide-washed beach gradually yields way to that portion of the lower beach that never experiences salt water inundation and this latter, to the upper beach and dunes.

### 3. *Vegetation of the Upper Beach and Sand Dunes.*

*Scaevola Thunbergii* and *Sporobolus pungens* are to be found in this zone, forming larger and stronger consocieties and associates than they do in the first described zone. They may be associated with one or more of the species described below.

#### (a) *Eragrostis cyperoides*.

This perennial, slightly ascending or erect grass with its lengthy creeping rhizomes is a common plant of this zone. It forms consocieties and also forms associates with *Stenotaphrum glabrum*, *Eragrostis glabrata*, *Ehrharta* spp., and *Sporobolus pungens*.

#### (b) *Stenotaphrum glabrum*.

*Stenotaphrum glabrum* is a prostrate grass forming strong consocieties on the beach as well as far inland. When abundant it builds up a dense, hard carpet and prevents the establishment of any but very assertive species. As a co-dominant or sub-dominant it is found in most of the communities of this zone.

#### (c) *Mesembryanthemum edule*.‡

The "T'gaukaum," or "Zuurvij," a fleshy prostrate forms dense consocieties of frequent occurrence. The spread of the species is rapid, being accomplished vegetatively as well as by seeds. Owing to the fruits being edible, man and apes have much assisted in its dispersal. *M. edule* has marked capacity for fixing the unstable sand, and has been employed extensively in drift-sand fixation work.

#### (d) *Cryptostemma (Microstephium) niveum*.

"Gousblom" with its densely canescent, fleshy foliage and white prostrate stems, develops extensive, flat consocieties that show little open ground in their

\* *Bremontier*, a French engineer, in 1778 published a treatise concerning the fixation of sand dunes by planting grasses.

† *Psamma arenaria* Beau.

‡ *M. pugioniforme* sometimes occurs with *H. edule*.

older portions. The plant spreads rapidly by vegetative means as well as by its wind-borne seeds. In common with *Sporobolus* and *Scaevola* it can withstand lengthy burial.

Its trial in drift-sand fixation is urged.

(e) *Ipomaea biloba* Forsk.

The "Wild Sweet Potato" is a common species in some localities but is rare in others. It forms fairly close consocieties or may form associations with *Scaevola*, the various grasses already mentioned, and less often with *Mesembryanthemum edule*. The plant is a rapid spreader and an efficient sand binder worthy of some attention in drift-sand practice. It grows readily from cuttings and is easily produced from seed.

(f) *Myrica cordifolia*.

The "Waxberry" is one of the most important sand-fixers along South African coasts. It is a ligneous shrub, seldom erect in habit, usually procumbent or sub-prostrate, its abundantly-developed branches spreading over the sand. The height of the plant may vary from eight inches to over thirty-six, but the average height is about twelve inches.

The species forms strong consocieties of considerable extent; other species often are associated with it, either as co- or sub-dominants. Its communities form the medium for the development of either Psammophilous Scrub or Psammophilous Macchia. Associated species commonly found with *Myrica cordifolia* are *Solanum aggerum*, *S. quadrangulare*, *Rhus crenata*, *Passerina rigida*, *Tetragonia fruticosa*, *T. decumbens*, *Mesembryanthemum* spp., and *Scaevola Thunbergii*, besides the Psammophilous grasses already mentioned as occurring on the beach. *Mariscus congestus* and *Ficinia lateralis* are also found occasionally. *Myrica quercifolia* occasionally grows with *M. cordifolia*, and on older dunes, *M. conifera* is an associate.

*M. cordifolia* produces abundant fruits; study of these by J. F. Phillips\* has shown that they require from 6 to eighteen months for germination unless the waxy covering is removed and the endocarp is softened by chemicals such as dilute sulphuric acid or dilute sodium hydroxide. About 40 per cent. of the annual crop is fertile, but only a very small number of the fertile fruits germinate. Seedlings are lesioned to death by the high temperature on clear, warm days.

Propagation by "layering" is possible if the operation be carried out with due care.

The species reacts strongly upon the sandy substratum, adding much litter, and much food material organic and inorganic, as well as binding the loose sandy particles so as to form a more stable soil.

(g) *Tetragonia* spp. (Aizoaceae).

*Tetragonia decumbens*, *T. spicata*, and *T. fruticosa* are found frequently, either in small consocieties or in small associations; they also mingle with other dune species. The first two spp. are fleshy prostrates, the third, fleshy, erect, and shrubby. The *Tetragonia* spp. form moderately close communities which effectively hold the sand.

Their fruits are winged, and being borne in profusion are dispersed far and wide. Germination and establishment, however, do not appear highly successful, few seedlings being observed.

(h) *Passerina rigida* Wikstr.

This ericoid plant of the Thymeleaceae possesses small, lanceolate leaves closely adpressed to a densely woolly-pubescent straight woody stem. It

\* Unpublished nursery-practice notes, 1923-24.

assumes heights varying from twelve inches to 48, according to locality, and forms consocieties usually close in nature and extensive in area. The species is rarely found in the macchia and scrub of the older dunes, its favoured locality being the unfixed dunes or the upper limits of the beach. Associated with *P. rigida* may be *Rhus crenata*, *Restio Eleocharis*, *Solanum aggerum*, *Erica speciosa*, and *Metalasia muricata*, as well as any of the other species mentioned as occurring in the zone under description.

*P. rigida* is a firm sand binder, and forms embryo dunes, but does not add much humus to the substratum on account of its leaves being minute and long persistent.

The anemophilous flowers are produced in great profusion, but as the fruits are few and of low fertility, the species does not spread rapidly.

Occasionally mingling with *P. rigida* and scarcely to be distinguished from it vegetatively, is *P. vulgaris* Thod.

(i) *Chironia baccifera*.

"Schilpbadbesje," bearing its profuse array of pink flowers at almost any time of the year, forms dense consocieties in the form of "tussocks," from twelve inches to twenty-four inches in height, and several yards in area.

The fixing and humus-adding capacities of the plant are considerable.

It spreads readily by seeds which are produced in large numbers and are bird-dispersed.

(j) *Stoebe cinerea*.

A stunted form of *Stoebe cinerea* is frequent on the upper dunes, its untidy, ericoid branches spreading far over the sand.

It is often found in consocieties but also occurs in associates, with *Metalasia* and *Eriocephalus* as co-dominants.

(k) *Metalasia muricata*.

"Blombos," a densely-branched, sclerophyllous, woody shrub varying in height from six inches to 10 feet, is widely distributed along the South African coasts. It forms very extensive and important sand-fixing, soil-improving consocieties, and also occurs as a co-dominant in various associates with such species as *Passerina rida*, *P. vulgaris*, *Erica speciosa*, *Stoebe cinerea*, *Osteospermum* spp.

There are several distinct varieties of the species which occur on the plateau, and in the mountains, as well as on the coast.

The commoner coastal varieties are *var. phyllicoides* Don., and *var. obtusiuscula* Harv.

(l) *Erica speciosa*.

On the upper portions of the beach and in various more sheltered positions among the dunes themselves, grows the hardy stunted form of *E. speciosa*. The plant sometimes occurs in consocieties, but usually in association with *Stoebe cinerea* and *Metalasia*. It is an important fixer and sand-improver, but is slow in extending its limits and in putting on height growth. Its seeds profusely, but few of the seedlings ever reach adult size. A severe *Cynodinium* disease attacks and kills off large numbers of the shrubs.

(m) Near water courses, where the sand contains more moisture, and at the bases of windward and leeward slopes of dunes, occur *Scirpus nodosus*, *Mariscus congestus*, and *Ficinia lateralis*, although the last named plant also occurs on much drier sites.

*Scirpus nodosus* forms marked consocieties, the characteristic tussocks being very dense within, but are separated from each other by open sand which may become colonized by *Sporobolus*, *Stenotaphrum*, or *Mariscus*. *Mariscus* builds

very open, straggling consociates, but effectively holds the soil in position by means of its widely-spreading roots. *Ficinia lateralis* does not grow in definite communities, but is scattered over most of the upper beach.

(4) *Very mixed communities consisting of most of the species already described as occurring on the upper beach and dunes*, form a transition stage to Psammophilous Macchia. Associated with these species are the following:—

*Ehrharta brevifolia*, *E. calycina*, *E. villosa*, *Cynodon dactylon*, *Agropyrum distichum* (exotic), *Salvia aurea*, *Sutherlandia frutescens*, *Psoralea bracteata*, *Heliophila* spp., *Statice scabra*, *Silene Burehellii*, *S. capensis*, *S. primulaeflora*, *Geranium incanum*, *G. ornithopodum*, *Pelargonium zonale*, *P. reniforme*, *P. capitatum*, *P. iocastrum*, *Helichrysum teretifolium*, *H. cymosum*, *H. nudifolium*, *H. rosum*, *H. rugulosum*, *H. ericaefolium*, *Felicia cehinata*, *Aster capensis*, *Vernonia anisochaetoides*, *Disparago ericoides*, *Cryptostemma calendulaceum*, *Cephalaria attenuata*, *Solarium rigescens*, *Cotyledon orbiculata*, *Crassula expansa*, and many others. These mixed communities play an important role in fixation and improvement processes, and to a very great extent prepare the soil for the carrying of Macchia.

(5) *Psammophilous Macchia*.

The mixed transition stage described above merges into Psammophilous Macchia, an extensive community clothing the upper dunes and portions of the first plateau for a mile or more inland. This type of macchia differs from others in that it occurs on white or grey sand derived from the ocean, possesses certain floristic features peculiar to it, and is much gnarled, twisted, and stunted as the result of wind action. The community, while varying considerably floristically according to locality, has the same physiognomy throughout. In the more extreme localities the macchia remains the climax community, especially if the supply of germules by scrub and bush species be poor. On better favoured sites climatically and edaphically—and receiving a fair supply of scrub and bush germinules—the macchia develops into scrub or bush.

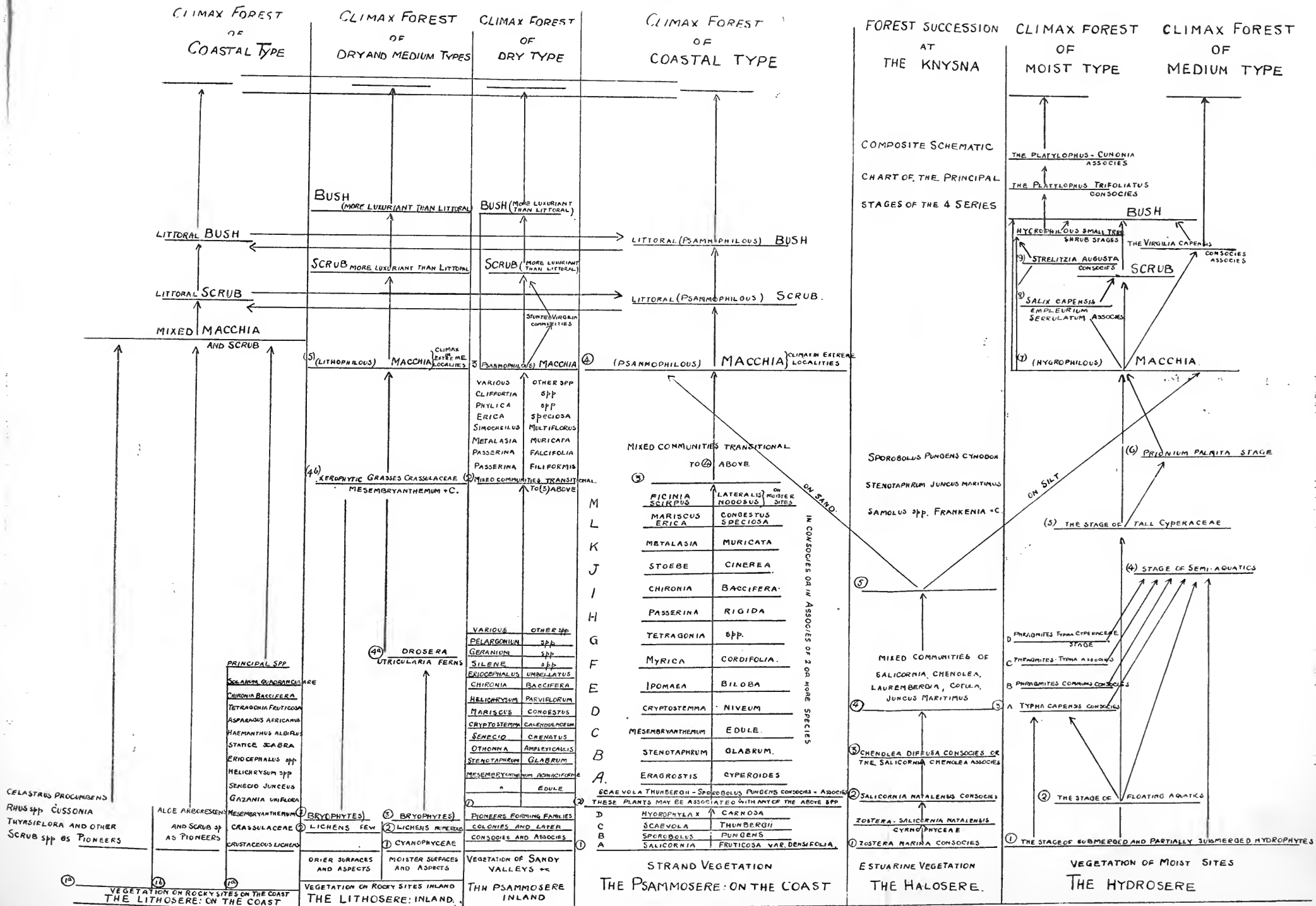
Psammophilous Macchia on the dunes and lower portions of the first plateau, experiences comparatively severe habitat conditions: exposure to continually-blowing winds often of great strength; high degree of insolation on clear days all the year round; a rainfall lower (by from ten to twenty inches per annum), than that of the first and second plateaux; a chemically-poor soil.

A general account of the principal floristic and sociological features only, is given here:—

The height of the community varies from 12 inches to over 72, but the average is about 36 inches. In portions the covering is exceedingly dense owing to the shrubby, much branched nature of the constituent plants, but in others open areas exist, populated by the prostrate *Stenotaphrum glabrum*, and less often by *Restio Eleocharis*. *Brunsvigia gigantea* occurs sparingly in such opener portions.

The most important part in the structure of the Macchia is played by woody shrubs, such as *Metalasia muricata*, *Osteospermum moniliferum*, *O. corymbosum*, *Phylica lasiocarpa*, *P. spp.*, *Erica speciosa*, *E. spp.*, *Cliffortia falcatifolia*, *C. filifolia*, *Psoralea spp.*, *Aspalathus spp.*, *Passerina vulgaris*, and *Barosma scoparia*, the smaller woody plants and herbs playing a subordinate role.

*Metalasia muricata* in its several coastal varieties is present in extensive consociates, and is a co-dominant in associates where *Erica speciosa*, *Phylica lasiocarpa*, *Osteospermum spp.*, are well represented. Associated plants of importance in such communities are: *Erica sessiliflora*, *E. curviflora*, *E. diaphana*, *E. chloroloma*, *E. decipiens*, *E. peltata*, *E. macsta*, *E. glumaefolia*,



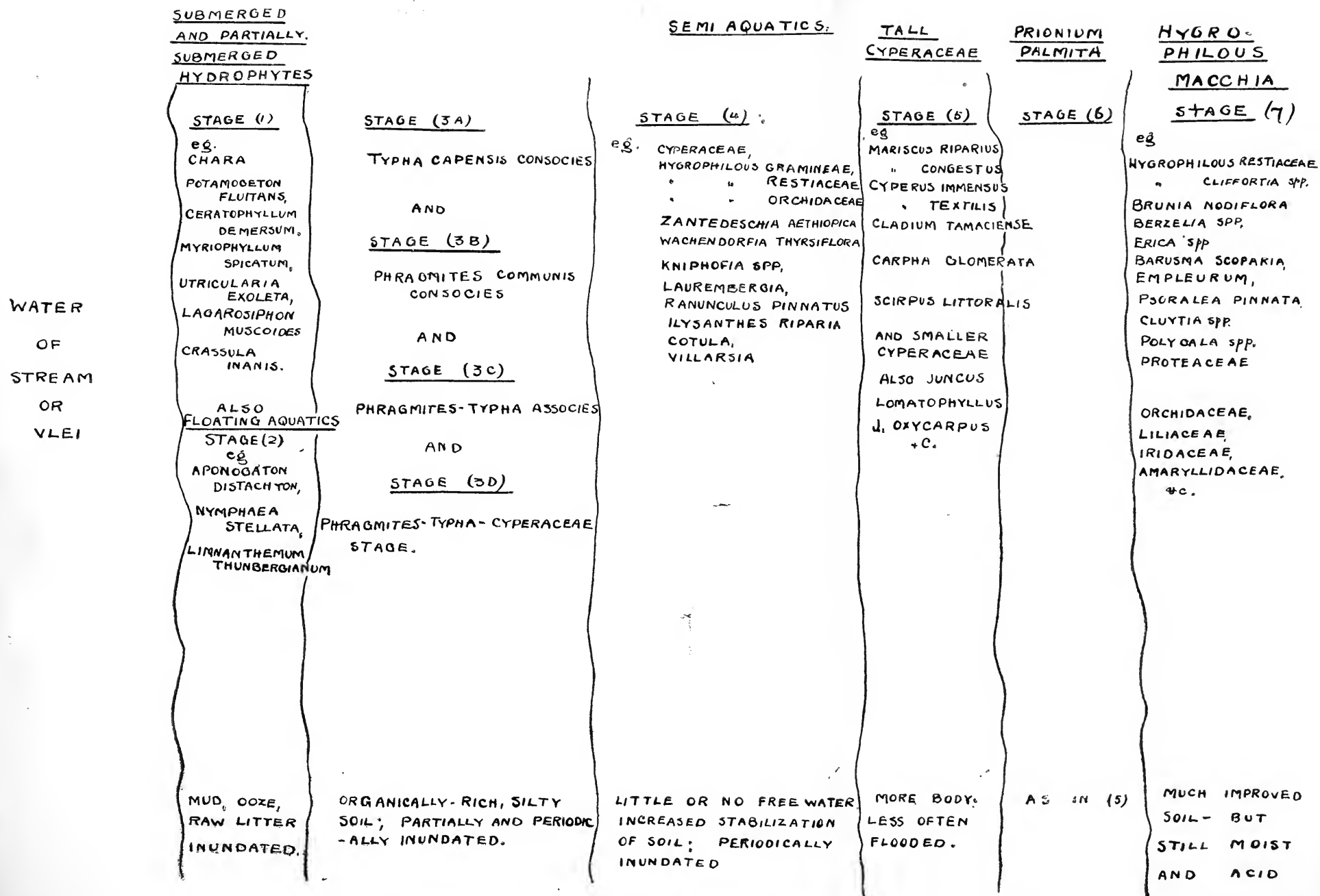


DIAGRAM: TYPICAL ZONATION :  
INITIAL STAGES OF THE HYDROSERE





# XVI.

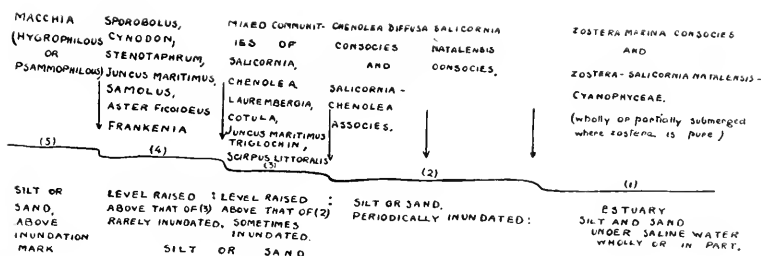
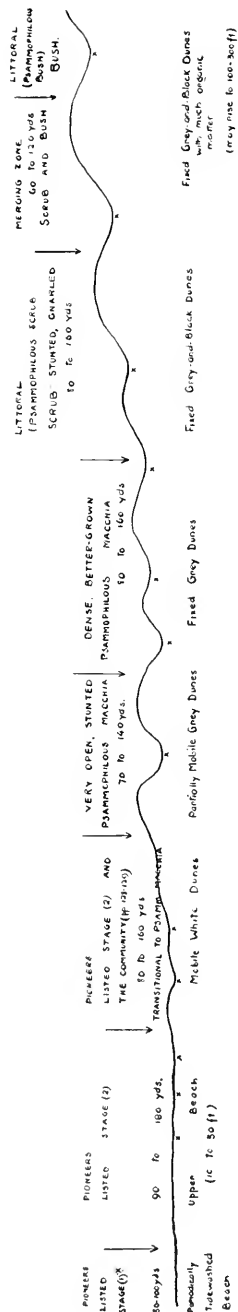


DIAGRAM : TYPICAL ZONATION  
THE HALOSERE.

MACRAM: TYPICAL ZONATION.

# THE PSAMMOSERE

ON THE COAST.



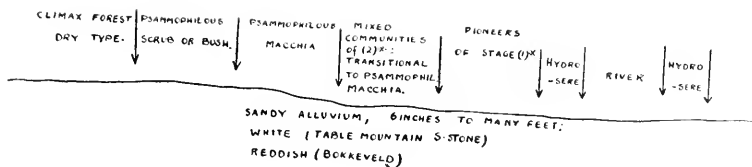
✕: THE STAGE NUMBERS REFER TO THE PYRAMIDS ON THE CREST COMPOSITE SCHEMATIC CHART p. 2.

x more sites due to Seepage.  
In such sites vegetation  
develops more rapidly than  
elsewhere.

# XVIII.

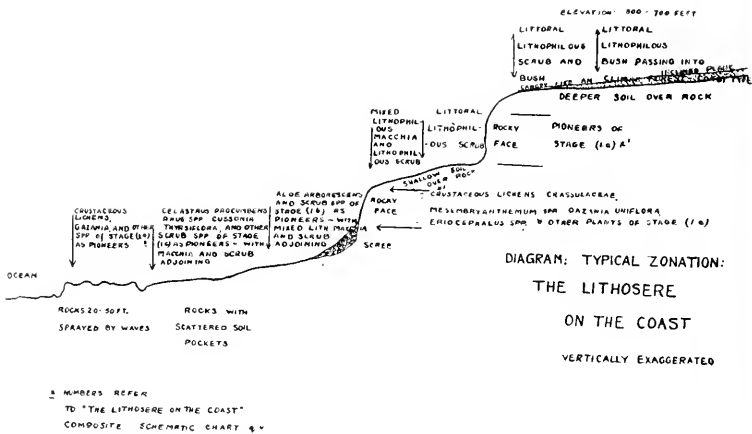
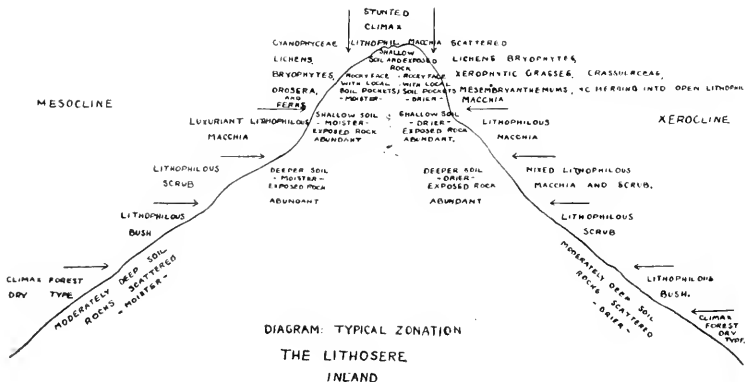
DIAGRAM TYPICAL ZONATION

## THE PSAMMOSERE INLAND.



X NUMBERS REFER TO  
THE PSAMMOSERE INLAND  
COMPOSITE SCHEMATIC  
CHART - V.V

## XIX.

 $\Sigma X.$ 

# XXI.

## XEROCLINE

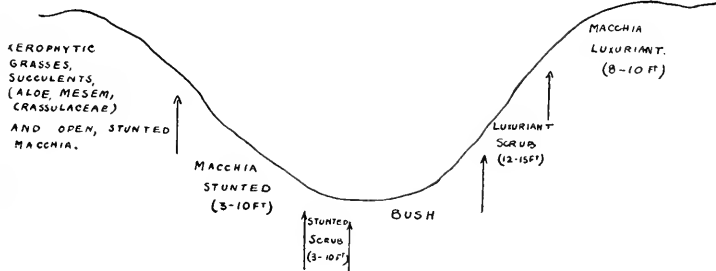
(HOT, DRY SLOPE)

- N, N.W., N.E., W ASPECTS -

## MESOCLINE

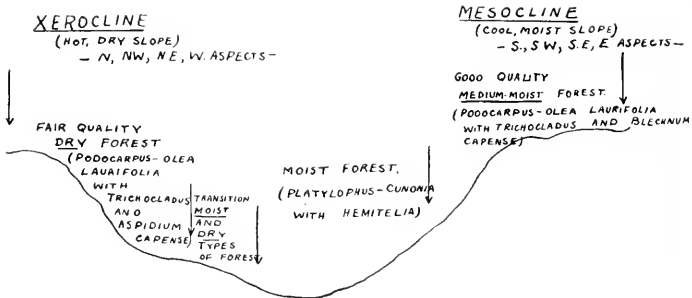
(COOL, MOIST SLOPE)

- S, S.W., S.E., E, ASPECTS -



DIAGRAMMATIC EXAMPLE OF THE INFLUENCE OF ASPECT (EXPOSITION)  
UPON MEDIAL SUCCESSIONAL STAGES. — GEOLOGICAL FORMATION  
(T.M.S) AND SOIL THE SAME.

## XXII.



DIAGRAMMATIC EXAMPLE OF THE INFLUENCE OF ASPECT  
(EXPOSITION) UPON PENULTIMATE AND ULTIMATE STAGES.  
GEOLOGICAL FORMATION AND SOIL THE SAME

# XXIII.

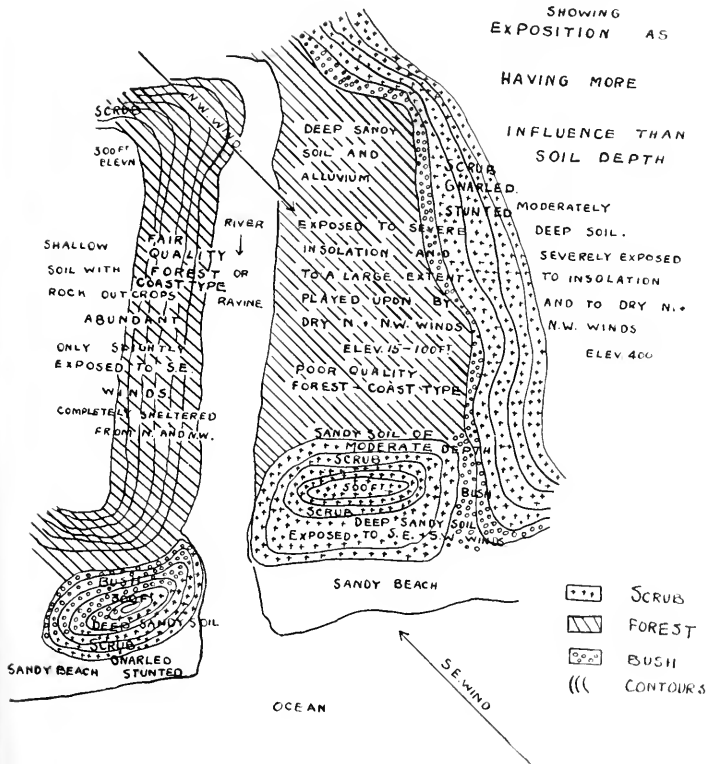
MESOCLINE

XEROCLINE

DIAGRAM  
SHOWING  
EXPOSITION AS

HAVING MORE

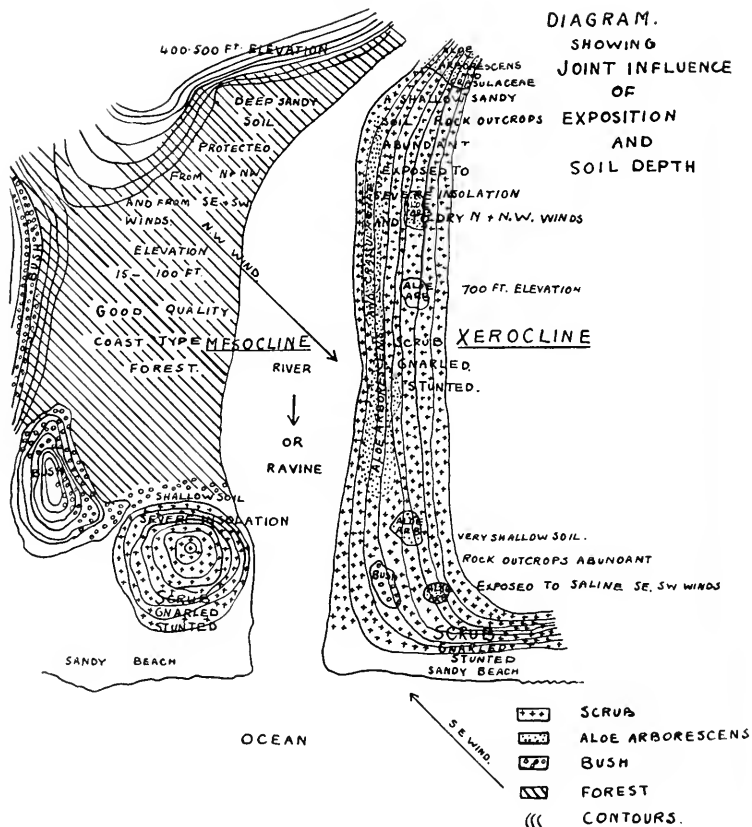
INFLUENCE THAN  
SOIL DEPTH





# XXIV.

DIAGRAM.  
SHOWING  
JOINT INFLUENCE  
OF  
EXPOSITION  
AND  
SOIL DEPTH



*Printzia Bergii*, *Indigofera procumbens*, *I. sulcata*, *I. stricta*, *I. polioties*, *I. disticha*, *Rhynchosia leucoscias*, *R. adenodes*, *R. caribaea*, *Argyrolobium Andrewsianum*, *A. collinum*, *Sutherlandia frutescens*, *Psoralea bracteata*, *P. tomentosa*, *P. pinnata*, *P. axillaris*, *Podalyria cuneifolia*, *Aspalathus ciliaris*, *A. Benthani*, *A. ericifolia*, *A. canescens*, *A. setacea*, *A. spinosa*, *Borbonia lanceolata*, *Silene capensis*, *S. Burchellii*, *S. primulaeflora*, *Murraltia ericaefolia*, *M. alopecuroides*, *M. satireoides*, *M. squarrosa* var. *ruscifolia*, *Zygophyllum fulvum*, *Z. morgsana*, *Z. flexuosa*, *Cardamine africana*, *Heliphila linearifolia*, *H. spp.*, *Lepidium decumbens*, *Passerina vulgaris* (rarely *P. rigida*), *Geranium spp.*, *Pelargonium spp.*, *Bubon hypoleucum*, *Chironia baccifera*, *Habenaria arenaria*, *Satvrium spp.*, *Bartholina spp.*, *Helichrysum paniculatum*, *H. teretifolium*, *H. maritimum*, *H. nudifolium*, *H. rosum*, *Pteronia incana*, *P. baccaroides*, *Aster capensis*, *A. affinis*, *A. echinatus*, *A. hispidus*, *Vernonia anisochaetoides*, *Gazania multiflora*, *Stoebe cinerea*, *Eriocephalus umbellatus*, *E. capitellatus*, *Disparago ericoides*, *Cullumia decurrens*, *Cephalaria attenuata*, *Senecio arnicaefolia*, *S. crenatus*, *S. ilicifolius*, *S. purpureus*, *S. cordifolius*, *Ursinia filicaulis*, *Othonna amplexicaulis*, *O. carnosa*, *Athanasia dimorpha*, *Oedera latifolia*, *Relhania quinquinervis*, *R. sessiliflora*, *Cryptostemma calendulaceum*, *Barosma lanceolata*, *Agathosma ciliata*, *A. apiculata*, *A. microphylla*, *Anthospermum prostratum*, *A. aethiopicum*, *Mesembryanthemum edule*, *M. acinaciforme*, *M. spp.* (both prostrate and fruticose), *Tetragonia spp.*, *Cotyledon orbiculata*, *Crassula ericoides*, *Ehrharta brevifolia*, *E. villosa*, *Themeda triandra*, *Eragrostis glabrata*, *Stenotaphrum glabrum*, *Ficinia spp.*, *Tetraria spp.*, *Mariscus congestus*, and several species of *Restio*, *Elegia*, *Thamnochortus*, and *Dovea*. Several of the species listed form consocieties and associates apart from the general mixed type of community described above: notable examples are: *Passerina vulgaris*, *Phyllica lasiocarpa*, *Osteospermum moniliferum*, *Erica sessiliflora*, *E. cerviflora*, *Eriocephalus capitellatus*, *Stoebe cinerea*, *Stenotaphrum glabrum*, *Restio Eleocharis*, *Mesembryanthemum edule*, *M. acinaciforme*, and *M. knysnanum*.

The Psammophilous Macchia leading to Scrub shows presence of such species as: *Royena pallens*, *R. glabra*, *Rhus crenata*, *R. lucida*, *R. villosa*, *Tarchonanthus camphoratus* (stunted form), *Buddleia salviaefolia*, *Chilianthus arboreus*, *Myrica conifera*, *Celastrus (Gymnosporia) buxifolius*, *Carissa arduina*, *Rhamnus prinoides*, *Grewia occidentalis*, *Olea exasperata* (*O. humilis* Eckl.), *Sideroxylon inerme*, and often *Celastrus acuminatus*, *Pterocelastrus variabilis* var. *variabilis*, and the semi-prostrate *Celastrus (Gymnosporia) procumbens*. The Scrub shrubs are usually far scattered, being separated from each other by Macchia taller and more luxuriant than the normal. The tendency is for the Scrub species to increase and to oust the plants of the Macchia.

The stages of the Psammosere inland are usually as follows:

As the development of vegetation on sandy areas inland is taking place on relatively small areas only, it is not possible to describe in any detail the various stages that take place between the initial colonization of bare areas and the building up of the climax communities. At most it is possible to trace briefly the stages at present represented along the larger river beds. It is, of course, extremely likely that these small communities reflect faithfully in miniature the general processes that must have taken place on a grand scale in past ages.

Areas: Sandy river beds.

Along some of the larger rivers there exist areas of pure quartz sand derived by erosive processes from the Table Mountain sandstone, as well as from such Bokkeveld beds as may occur along the valleys. The length of such deposits may be many miles, the width seldom 100 yards, the depth from 6 inches to many feet.

The sand possesses little or no clay or silt, and scarcely any organic matter; the water-content is usually low, except near the banks of the rivers. Owing to their lying in valleys, in which there is slight movement of air, the deposits take up high surface temperature (150 to 160 deg. Fahr.) during the midday hours on bright, warm days in summer. In winter they are kept relatively cool, as the sun rarely plays upon them for more than several hours per day. On the whole, the inland initial areas are not nearly so severe as those of the sandy beaches already described.

Pioneer species very commonly found are: *Mesembryanthemum edule* and *M. aënaforme*, which form dense consocieties and assoeies, their succulent ranks covering and binding the loose sand. These plants show no evil effects on being inundated periodically. During floods they collect much water-borne inorganic and organic matter, which appreciably assists in raising the general level of the communities, as well as improves the quality of the substratum.

*Stenotaphrum glabrum* develops large consocieties, which take the form of rich, prostrate mats, most effective in holding the sand in place.

The opener portions of such consocieties are invaded by such plants as *Senecio erenatus*, *Stoebe capitata*, *Othonna amplexicaulis*, *Cryptostemma calendulaceum*, *Mariscus congestus*, *Helichrysum parviflorum*, *Chironia baccifera*, *Eriocephalus umbellatus*, *Peucedanum ferulaceum*, *P. capense*, *Sutera* spp., *Silene capensis*, *S. Burchellii*, *Geranium* and *Pelargonium* spp.

Following the pioneer stages are commonly *Passerina filiformis*, *P. falcifolia*, *P. vulgaris*, *Metalasia muricata*, *Erica speciosa*, *Simoeilus multiflorus*, *Phylla axillaris*, *Phyllia* spp., *Psoralea pinnata*, *Cliffortia* spp., which form consocieties and assoeies of some extent, and prepare the way for ordinary *Psammophilous macehia*. Gradual improvement of soil conditions is brought about, the organic content being much increased, the substratum being converted from one of innutritious sand to a fair quality sandy loam.

The *maechia* may either remain subelimax, chiefly owing to absence of germules of scrub or forest species, or may, directly or through the agency of *Virgilia capensis*, yield play to river-bank scrub or bush. The development of forest from the scrub or bush seems to be a very slow process, owing no doubt to the general absence of those climatic factors so essential to forest progress—high humidity and reduced air temperature.

#### THE LITHOSERE.

Areas: rocky portions of the coast, of the plateaux, and of the mountains.

While the area occupied to-day by the lithoseral stages is considerable, the greater portion of this carries the ultimate and penultimate stages of the succession, the pioneer stages being represented to an infinitely lesser degree. Judging from the probable, more recent geological history of the region, very extensive areas of sheet and broken rock must have been available initially for the development of the first pioneer communities of the Lithosere. Such extreme rocky areas, doubtless, in some instances, were rapidly colonized by pioneer *Cyanophyceae*, *Lichens*, and *Bryophyta*, which reacted in the direction of rock-decomposition and soil production. Owing to the mountain barriers immediately north of the plateaux having received little disturbance since Jurassic times, there must have been upon their summits and slopes a fair assemblage of flowering plants conveniently situated for invasion of the plateaux. Probably pioneer *Phanerogams* soon followed on the *Cryptogams*, and furthered the formation of a soil covering.

The stages of the Lithosere to-day may best be studied on the mountain slopes, along rocky river valleys, and along the rugged, rock-bound coast line.

For sake of clearness it is desirable to treat separately the succession commencing on rocky sites *inland* and that commencing on rocky sites on the *coast*.

The succession *inland* is described first.

Two distinct types of rocky surface are commonly found on the mountain summits and slopes and in rocky valleys :—

- (a) Surfaces exposed to severe insolation, experiencing N., N.E., and N.W. or W. aspects, and wet for short periods following heavy rain only. These show absence of Cyanophyceae, and are relatively poorly clad with Lichens and Bryophytes. Soil accumulates through atmospheric weathering and gravity, or is wind-borne. Pioneer plants are either scattered Lichens and Bryophytes, or more often Xerophytic grasses and Crassulaceae.
- (b) Surfaces exposed to moderate insolation, experiencing S., S.W., or S.E. or E. aspects, and kept moist for long periods after rain, either in virtue of their cool setting or through seepage. Such surfaces support a rich covering of Cyanophyceae in the initial stages : later Cyanophyceae and lichens, hepatics, and mosses appear. Grasses, Crassulaceae, and macchia plants follow on the Cryptogams.

The general succession is as follows :—

1. *Cyanophyceae* (principally species of *Calothrix*, *Schizothrix*, *Stigonema*, *Gloeocapsa*).

These form a covering which is slimy during moist weather and skin-like during dry. The reaction upon the rocky surface is an effective one, resulting in the production of a fine dusty layer of disintegrated material containing a fair percentage of organic matter.

2. *Lichens* (principally species of *Xanthoria*, *Parmelia*, *Lecanora*, *Pertusaria*, *Umbilicaria*, *Cladonia*).

These mingle with the Cyanophyceae, forming extensive communities in some sites, but very open ones in others. The action of the lichen pioneers is to produce additional dusty material from the rock, and to add to this organic matter resulting from the decomposition of thalloid material cast by themselves.

3. *Bryophyta*.

The mosses and hepatics follow very soon after the lichens. The more important are *Racomitrium caninum*, *Dicranum tabulare*, species of *Grimmia*, *Andreaea*, *Hedwigia*, *Polytrichum*, *Pogonatum*, *Fimbriaria* ; *Bryum argenteum*, *Bryum alpinum* : species of *Brachymerium*, *Campylopus*, *Fissidens*, *Marchantia*, *Riccia*, and *Anthoceros*.

The Bryophytes add considerably to the soil covering, not only by disintegrating further rock material, but also by collecting wind-borne matter and by returning copious amounts of organic matter to the substratum.

- 4 (a). *Drosera*, *Utricularia*, and *Various Ferns*.

On moister sites the Bryophytes are followed by *Drosera capensis*, *D. cuneifolia*, *D. cistiflora*, *Utricularia capensis*, stunted *Pellaea viridis*, *P. quadripinata*, stunted *Gleichenia polypodioides*, much stunted *Pteridium aquilinum* : *Polypodium lanceolatum*, *Hymenophyllum tunbridgense*, *Lycopodium carolinianum*, *Blechnum tabulare*, *B. attenuatum*, *Asplenium cuneatum*, *Dryopteris Bergiana*. These plants continue the work commenced by the pioneers already described — decomposition of the rock surface and accumulation of organic matter.

- 4 (b). *Xerophytic Grasses*, *Crassulaceae*, *Mesembryanthemum spp.*

On the drier sites the Bryophytes are followed by the above plants, or the plants of stage 4 (a) may be followed by these.

The principal grasses are *Achneria capensis*, *Pentaschistis Thunbergii*, *P. angustifolia*, *Ehrharta brevifolia*, *Danthonia stricta*, and *Koeleria cristata*\*; the principal Crassulaceae are *Crassula perfoliata*, *C. platyphylla*, *C. rosularis*, *C. rubricaulis*, *C. turrita*, *C. fruticulosa*, *C. expansa*, *C. rhomboidea*, *C. clavifolia*, *C. obvallata*, *C. corymbulosa*, *Coyledon orbiculata*, *C. rhombifolia*: *Mesembryanthemum edule*, *M. acinaciforme*, *M. spp.* (these require identification by a specialist†), are important plants, covering quite large areas, and reacting strongly upon the rocks. Other important plants are *Senecio junccea* (which thrives in the stoniest, warmest, driest sites), *Aster filifolius*, *Gerbera piloselloides*, *Helichrysum paniculatum*, *Commelina africana*, *Montinia acris*, *Haworthia* and *Gasteria spp.*

This stage practically covers the rocky surfaces with vegetation.

##### 5. *Lithophilous Macchia*.

The foregoing stage [4 (b)] prepares the way for the macchia plants proper, by deepening the soil cover, enriching it chemically and biotically, and by improving the water conditions.

Representative plants of *Lithophilous macchia* are the following: *Erica speciosa*, *E. cerinthoides*, *E. viridiflora*, *E. diaphana*, *E. Sparrmannii*, *E. transparens*, *E. albens*, *E. petraeae*, *E. copiosa*, *E. stylaris*, *E. imbricata*, *E. brevifolia*, *E. seriphiifolia*, *Blaeria fuscescens*, *Simocheilus multiflorus*, *Cliffortia octandra*, *C. filifolia*, *C. ilicifolia*, *Pteronia incana*, *P. stricta*, *Chrysocoma tenuifolia*, *Aster affinis*, *A. echinatus*, *A. erigeroides*, *A. filifolius*, *Amellus strigosus*, *Conyza ivaefolia*, *Helipterum eximium*, *H. gnaphalioides*, *Helichrysum odoratissimum*, *H. anomalum*, *H. nudifolium*, *H. serpyllifolium*, *H. appendiculatum*, *H. lancefolium*, *Stoebe microphylla*, *S. cinerea*, *Metalasia muricata*, *Relbania squarrosa*, *Athrixia capensis*, *A. heterophylla*, *Leyssera gnaphalioides*, *Printzia Bergii*, *Athanasia pubescens*, *A. dentata*, *A. pinnata*, *Matricaria glabrata*, *Senecio crenatus*, *S. oliganthus*, *S. longifolius*, *S. juncens* (on rocks), *Othonna parviflora*, *O. amplexicaulis*, *Ursinia trifida*, *U. anethoides*, *Haplocarpha lyrata*, *Cullumia decurrens*, *Gerbera spp.*, *Heliophila spp.*, *Muraltia stipulacea*, *M. filiformis*, *M. mixta*, *M. alopecuroides*, *Hermannia salviaefolia*, *H. spp.*, *Pelargonium dipetalum*, *P. radulaefolium*, *P. cafferum*, *P. myrrhifolium*, *P. scabrum*, *Oxalis purpurea*, *O. variabilis*, *Diosma vulgaris*, *Barosma scoparia*, *B. ovata*, *Agathosma serpyllacea*, *A. microphylla*, *A. pubescens*, *Agathosma spp.*, *Phylica verticillata*, *P. stipularis*, *P. lasiocarpa*, *P. rosmarinifolia*, *P. paniculata*, *P. axillaris*, *P. villosa*, *Phylica spp.*, *Cyclopia subternata*, *Podalyria glauca*, *P. Burchellii*, *P. calyptrata*, *Amphithalea sp.*, *Aspalathus ciliaris*, *A. Benthami*, *A. rigescens*, *A. aciphylla*, *A. suffruticosa*, *Aspalathus spp.*,‡ *Crotalaria purpurea*, *Loddigesia collinum*, *Psoralea pinnata*, *P. axillaris*, *Indigofera filifolia*, *I. coriacea*, *I. flabellata*, *Indigofera spp.*, *Rhyncosia glandulosa*, *Berzelia cordata*, *Brunia nodiflora*, *Pseudobaeckea racemosa*, *Pharnaceum dichotomum*, *Lobelia hirsuta*, *L. pubescens*, *L. villosa*, *L. repens*, *L. linearis*, *Protea cynaroides*, *P. humiflora*, *P. grandiflora*, *P. longiflora*, *Leucadendron adscendens*, *L. scabrum*, *L. eucalyptifolium*, *L. plumosum*, *L. aemulum*, *L. decurrens*, *Leucospermum conocarum*, *L. glabrum*, *L. attenuatum*, *Gladiolus spp.*, *Antholyza aethiopica*, *A. cafferum*, *A. spp.*, *Aristea spp.*, *Babiana spp.*, *Geissorhiza spp.*, *Bobartia spp.*, *Homeria collina*, species of *Ixia*, *Hesperanthera*, *Moraea*, *Watsonia*, *Caesia Thunbergii*, *Bulbine spp.*, *Bulbinella spp.*, *Eriospermum spp.*, *Tuibaghia spp.*, *Urginea spp.*, *Anthericum spp.*, *Haemanthus spp.*, *Hypoxis spp.*, *Vallota purpurea*, *Ficinia*

\* Occurs in Europe; widespread.

† Specimens sent to Mrs. L. Robus.

‡ Especially *A. frankenioides* and *A. aciphylla*.

spp., *Tetraria* spp., *Schoenoxiphium* spp., *Thamnochortus* spp., *Restio* spp., *Dovea* spp., *Hypodiscus* spp., *Willdenovia* spp., *Leptocarpus* spp., *Cannamois* spp., *Elegia* spp., various *Orchidaceae*, and various other *Monocotyledons* and *Dicotyledons*.

While the listed plants do not occur together in one and the same spot, they are representative of the stocking of extensive areas of country that have had their origin in bare rock surfaces. The community built up is *macchia*, which remains climax along the mountain summits and upper slopes, and on portions of the foot-hills, or which develops into scrub, bush, or forest in congenial sites.

While the *macchia* originating in the *Lithosere* may show a number of species that occur in the *macchia* of the *Psammosere* and *Hydrosere*, it is clear that a certain number of the species are peculiar to it. Its structure, moreover, is different from that of *Psammophilous* and *Hygrophilous Macchia*, being of lesser height, of lesser luxuriance, and of opener nature. *Lithophilous Macchia*, in addition, is richer in grasses than are the other types. Either mixed with the opener, shorter *macchia*, or occurring in small consocieties or associates in shrub-tree areas within the latter, particularly on dry northern slopes, are such grasses as *Ehrharta brevifolia*, *E. erecta*, *E. capensis*, *E. calycina*, *E. Rehmanni*, *E. subspicata*, *Danthonia stricta*, *D. disticha*, *D. lanata*, *D. cincta*, *D. eurva*, *D. papposa*, *D. Zeyheriana*, *Achneria capensis*, *Pentastichis angustifolia*, *P. Thunbergii*, *P. heptamera*, *Koeleria cristata*, *Brizopyrum capense*, *B. brachystachyum*, *Lasiachloa longifolia*, *L. hispida*, *Eragrostis eurvula*, *E. chloromelas*, *E. brizoides*, and species of *Aristida*, *Chloris*, *Harpechloa*, *Leersia*, *Lepturus*, *Panicum*, *Pennisetum*, *Polypogon*, *Trachypogon*, *Setaria*, and *Pollinia*.

*Themeda triandra*, in areas receiving less rainfall, and particularly on northern slopes in such areas, forms fairly extensive consocieties, affording excellent fodder compared with most of the other south-western and *macchia* grasses. Toward the eastern limit of the region, scattered *Andropogon nardus*,\* *A. hirtus* and *H. eucomus* are found, probably ruderals from the eastern grass-veld.

The development toward scrub or bush is brought about by increased luxuriance of the chief *macchia* species and the entry of pioneer scrub species, such as *Royena pallens*, *Celastrus buxifolius*, *Rhus lucida*, *R. ineana*, *R. undulata*, *R. longispina*, *R. villosa*, *Euclea lanceolata*, *Carissa arduina*, *Pittosporum viridiflorum*, *Chilianthus (oleaceus) arboreus*, *Rhamnus prinoides*, *Osteospermum moniliferum*, *Myrsine africana*, *Tarchonanthus camphoratus*, *Virgilia capensis*, in a stunted form, may appear at this stage. *Aloe* spp. are sometimes associated, with the scrub forms in this transition stage.

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The development on the coast is as follows:—

The succession commencing on the bare rocky crags and slides of the coast shows several features of interest. *Cyanophyceae* are practically entirely absent, the rocks being so exposed to wind and insolation that they are usually kept dry. *Lichens*† are represented by *Crustaceous* forms, and by a few foliose and fruticose species in more sheltered sites. *Mosses* and *hepatics*, too, are practically wanting. The *Crustaceous lichens* paint the rocks red, yellow, green, grey, and brown, but appear to disintegrate the surfaces at a very slow rate.

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\* Occurs in scrub at De Vlugt.

† Most of these are undescribed as yet.

The most efficient pioneers are succulents and scrub plants. Three distinct types of pioneer community are to be distinguished, and these are described below :—

1 (a). *Crassulaceae, Mesembryanthemum spp., Chironia, and other spp.*

Crassulaceae (chiefly *C. perfoliata*, *C. rhomboidea*, *C. rubricaulis*, *C. rosularis*, *C. platyphylla*, *C. fruticulosa*, and *Cotyledon orbiculata*), *Mesembryanthemum edule*, *M. knysnanum*, *M. acinaciforme*, *M. tenellum*, *M. spp.*, *Tetragonia fruticosa*, *Gazania uniflora*, *Senecio juncus*, *Helichrysum paniculatum*, *H. parviflorum*, *H. crenatus*, *Eriocephalus umbellatus*, *H. capitellatus*, *E. racemosus*, *Chironia baccifera*, *Solanum quadrangulare*, *Statice scabra*, *Passerina rigida*, *Aristea capitata*, *Haemanthus albiflos*, *Asparagus africanus*, *Freesia refracta*, *Antholyza aethiopica*, *Agapanthus umbellatus*, *Stenotaphrum glabrum*, and *Sporobolus pungens*, are the more important species of this particular pioneer stage. The plants find root-hold in the crevices in the rocks, and gradually add to the soil covering through disintegration of the rock, collection of aeolian-borne matter, and return of organic matter. The species are usually found in small *families* (groups of individuals belonging to the same species) and *colonies* (initial communities of two or more species), which ultimately produce consocieties and associations of some extent. Much open rocky surface appears between the various small communities of this stage.

An alternative pioneer community is 1 (b) below.

1 (b). *Aloe arborescens and Scrub Pioneers.*

The seedlings of the succulent *Aloe arborescens* find root-hold in the crevices in the rocks, and within a few years so enlarge these crevices, and so collect sandy material, that they form less precarious growing centres for themselves. Development of the aloe seedlings continues for a number of years, until the plants attain heights ranging from 6 to 18 feet : they are always much branched, and form an appreciable canopy when at all close together. Under cover of the aloes appear scrub pioneers, which find root-hold in various cracks, crevices, and local sandy spots. The more important species appearing at this stage are *Capparis citrifolia*, *C. Guenzii*, *Nieuhria pedunculosa*, *Euclea racemosa*, *E. lanceolata*, *Royena pallens*, *Celastrus buxifolius*, *C. nemorosus*, *Celastrus acuminatus*, *C. peduncularis*, *Hartogia capensis*, *Cussonia thyrsiflora*, *Sideroxylon inerme*, *Trehonanthus camphoratus*, *Chilianthus arboreus*, *Myrsine africana*, and *Carissa arduina* : minor plants are *Chironia baccifera*, *Crassula perfoliata*, *C. rubricaulis*, *C. rosularis*, *Cotyledon orbiculata*, *Agapanthus umbellatus*, *Haemanthus punicus*, *H. albiflos*, *Hypoestes aristata*, *Polygala ericaefolia*, and *Stachys aethiopica*. The communities extend in area, and are later joined by additional scrub forms, ultimately developing into typical littoral scrub. In the latter community, *Aloe arborescens* is gradually killed out, owing to the dense shade cast.

An alternative pioneer community is 1 (c) below.

1 (c). *Celastrus procumbens—Other Scrub Pioneers.*

Occasionally *Celastrus procumbens*, *Rhus crenata*, *Capparis citrifolia*, *C. Guenzii*, *Cussonia thyrsiflora*, *Grewia occidentalis*, *Carissa arduina*, *Acokanthera venenata*, *Euclea racemosa*, *E. lanceolata*, *E. macrophylla*, *Sideroxylon inerme*, and several other scrub species are the first colonizers of bare rocky surfaces. These hardy and adaptable forms find slender root-hold in various cracks and crevices, and form stunted, prostrate, but exceedingly rigid and dense mats of woody, sclerophyllous vegetation that in parts completely cover the rocks. Rocks within the reach of the spray of the ocean, and receiving the severest of insolation, and subject to relatively long drought periods, often bear communities of gnarled, malformed shrubs of the species listed, the height ranging

from 6 to 18 inches. By very slow but very steady improvement of edaphic conditions, and the extension of some shelter to the regeneration of incoming species, these grotesque communities may develop into ones that are taller and more luxuriant. In very extreme sites it seems that they must remain in a subclimax state for very lengthy periods. The general procedure, however, is for littoral scrub and littoral bush to develop from these pioneer scrub communities.

## 2. *Mixed Macchia and Scrub Forms.*

As shown in the schematic chart, the pioneer stages (1a, 1b, 1c) already described develop into littoral scrub. Before this community is built up, however, there appears an intermediate one, composed of mixed macchia and scrub forms. Stage I (a) always develops to this particular community before building up littoral scrub, but in the stages I (b) and I (c) this community may be omitted.

The principal plants of this mixed community are as follows: *Erica speciosa*, *E. formosa*, *Phylica lasiocarpa*, *Barosma scoparia*, *Metalasia muricata*, *Osteospermum moniliferum*, *O. corymbosum*, *Restio eleocharis*, *Rhus crenata*, *Rhus lucida*, *Royena pallens*, *Euclea* spp., *Carissa arduina*, *Capparis* spp., *Celastrus procumbens*, *C. buxifolius*, *C. nemorosus*, *Solanum rigescens*, *Pavonia mollis*, *Zygophyllum morgsana*, *Z. fulvum*, *Z. flexuosum*, *Peucedanum capense*, *Heteromorpha arborescens*, *Grewia occidentalis*, *Sideroxylon inerme*, *Allophyllus decipiens*, *A. erosus*, *Olea capensis* (very much stunted), *Olea exasperata* (a diminutive *Olea*), the scandent *Cussonia thyrsiflora*, and the lianes *Rhoicissus*, *R. digitata*, *Cissus cuneifolia*, *Scutia (indica) Commersonii*, which are often prostrate or semi-prostrate. *Passerina rigida*, small *P. falcifolia*, *Stoebe cinerea*, *Podalyria* spp., *Crotalaria* spp., are found on some sites. *Pelargonium* spp. are usually present.

The listed plants usually occur in mixed associates, although quite extensive consociates of *Erica speciosa*, *Phylica lasiocarpa*, *Metalasia*, *Rhus crenata*, and the prostrate lianoid *Cussonia* and *Rhoicissus capensis* are to be found.

The species produce regeneration very slowly, except in the instances of *Osteospermum*, *Metalasia*, and *Rhus crenata*, and must take very lengthy periods to complete the covering of the crags and slides of rock.

This stage sees the general incoming of scrub and bush species, which in time convert the open, mixed macchia-scrub community into littoral scrub proper, an exceedingly dense—almost impenetrable—shrub-stunted tree community described in Chapter V.

The various stages of the four main seres and of their several locality types are shown in the Schematic Chart. This chart, in addition, shows such relationships as exist between certain communities of the several seres.

The general successional tendencies shown by vegetation in the region are summarized in Chapter VIII, Part (a).

Scrub and scrub species and bush are described in Chapter V, while forest is treated in Chapters VI, VII, IX, and X.

## ASPECT ALTERNES.

Before concluding this chapter, a brief description of *alternation in medial successional stages*, produced by aspect, is essential. The influence of exposition on forest proper is referred to on pages 25, 40, (also Table VII), 53, 187-188, 195-199, and therefore requires no description here.

The northern, north-western, north-eastern, and western aspects usually constitute *Xeroclines*, or the dry, warm slopes, while the southern, south-western, south-eastern, and eastern form the *Mesoclines*, or moist, cool slopes.



The sides of valleys and of hills afford striking examples of the *alternation* brought about by aspect, acting through the prime ecial factors, light-intensity, air and soil temperatures, and moisture-content of the soil. The xeroelines receive stronger light for longer periods than do the mesoclines, while the mean temperatures of air and of soil are higher by 5-10 degrees Fahr., according to vegetation covering, colour and texture of soil, and angle of slope. The mean moisture-content of mesoclines is higher by 5-50 per cent. (on dry weight), according to vegetation covering, nature and depth of soil, and angle of slope.

It is necessary to point out that, in a number of instances, *seeming* aspect alternes are *really* alternes produced by differences either in geological formation (e.g., Bokkeveld and T.M.S. outcrops on opposite sides of valleys and hills), or in soil depth: naturally, such are not to be confused with aspect alternes.

The following examples of aspect alternes in medial stages suffice to indicate the important *role* of exposition:—

- (1) The *Xerocline* of a valley or hill shows *stunted macchia* 2-3 feet high, while the *mesocline*, often not more than 50 yards distant, shows *luxuriant macchia* to 15 feet in height.
- (2) The *xerocline* of a valley or hill shows *tall macchia* to 15 feet in height; the *mesocline*, *bush* or *bush transitional to forest*.
- (3) The *xerocline* shows *scrub of stunted nature*, the *mesocline*, *luxuriant scrub* and *bush transitional to forest*.
- (4) Further inland, toward the north and north-east of the region, the *xerocline* shows *mixed scrub and grass* (e.g., *Themeda triandra*), the *mesocline* *tall macchia*. For this reason, the *xerocline* affords better pasture than the *mesocline*.

The lines of division between the communities of opposing slopes of valleys or of the opposite slopes of hills, are usually sharp, but in some instances transitional communities link the populations of the different aspects.

From a study of the prime habitat factors of aspect alternes and of their vegetation, it seems clear that a climatic swing in the direction of increased humidity would result in the advancement of the vegetation of the mesoclines, whereas a swing toward aridity would accelerate the development of that of the xeroelines.

## Chapter V.

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SCRUB AND BUSH.



## CHAPTER V.

## SCRUB AND BUSH.

## (a) SCRUB.

Scrub develops from macchia on the coast and inland alike, and, as pointed out in the description of the coastal Lithosere, Chapter IV, it may arise from pioneer scrub communities that are at first of relatively open nature.

Two scrub types are to be distinguished, these being habitat modifications of the same community. The type may best be defined as *Littoral Scrub* and *Inland Scrub*. As the names imply, the former occurs within short distances of the sea, the latter on the plateaux and foot-hills of the interior. Such differences as exist between these types are entirely structural; the flora is common to both.

*Littoral scrub*, whether it originates in the Lithosere or the Psammosere, or develops from local hydrosere communities fringing the river estuaries, is always more stunted, more gnarled, more slow-growing than scrub holding ground away from the severe atmospheric and edaphic conditions of the sea shore. One of the most important factors responsible for the moulding of the physiognomy of *littoral scrub* is the landward wind prevailing during the warmer hours of practically every day in the year. The wind shears down, as it were, the crowns of the scrub dominants, so that the general canopy from a distance assumes the aspect of an inclined plane, the lowest portion of which occurs nearest to the sea. In addition, branch development in the direction from which the prevailing wind is blowing is inhibited, with the result that abnormally active development takes place in the opposite direction. Growth in the short stems, too, is practically entirely in the direction away from the prevailing wind—grotesque, flattened, or ribbon-like growths often being produced in this way.

The foliage is usually more succulent and the leaves smaller in *littoral scrub* than in *inland*, species for species. On the whole, the littoral type is denser and possesses a closer, less interrupted canopy than the inland type.

*Littoral* and *inland scrub* ranges in height from several feet (at the edges of the coastal cliffs, and on the hottest, driest, shallowest-soiled sites inland) to 15 feet. The species of which scrub is composed, no matter whether they are capable of growing to large dimensions under congenial conditions or not, remain stunted owing to the adverse conditions climatically and edaphically. The community has to react not only upon the edaphic conditions ere better growth is produced in species capable of showing it, but has also to produce suitable atmospheric conditions. Through a gradual process of canopy improvement, through gradual increase in height of that canopy (i.e., building up of bush on ground that previously bore short scrub), the humidity of the air is increased, the temperature of the air is sufficiently reduced, and the rate of evaporation brought down appreciably.

The most important features respecting scrub are as follows:—

- (a) The large number of subtropical species that occurs within it.
- (b) The abundance of true woody shrubs and stunted trees; the development of spines; the increase in numbers and in individuals of lianes as compared with macchia; the occasional occurrence of succulents: species of *Cotyledon* and *Crassula*, *Haworthia*, *Stapelia*, *Aloe*.
- (c) The impenetrable, densely-massed nature of the vegetation.
- (d) The rarity of regeneration of typical scrub shrubs, but the gradual increase in number, in high scrub, of seedlings of forest trees of pioneer nature.

- (e) The general absence of dominance, except over exceedingly small areas. Dominance is not a marked feature in high forest at the Knysna, but in scrub it is even a rarer one. There is a general mixing of shrub and stunted tree forms.
- (f) Important canopy-forming species are as follows: *Royena pallens*, *Euclea lanceolata*, *E. racemosa*, *Pterocelastrus variabilis* (much stunted); *Scolopia Zeyheri* (heavily armed and much stunted); *Apodytes dimidiata* (in the form of a grotesque-shaped, gnarled shrub); *Celastrus buxifolius* (with a wealth of formidable spines and few leaves); *Celastrus acuminatus* (with reduced foliage and heavy arms); *Rhus lucida* (sometimes in consocieties); *R. incana*; *R. mucronata*; *R. longispina*; *Pittosporum viridiflorum* (abundant locally in dry river valleys inland); *Olea verrucosa* (on dry sites inland); *Carissa arduina*; *Scutia indica* (shrub form); *Osyris abyssinica*; *Plectronia ventosa* (which forms armed consocieties); *Myrsine melanophloeos* (much reduced in size); *M. africana*; *Grewia occidentalis* (shrubby or lianoid); *Capparis citrifolia* (liane); *Dodonaea Thunbergiana* (local, near streams, in small consocieties); *Ekebergia capensis* (much gnarled and stunted); *Heteromorpha arborescens*; *Myrica conifera*; *Tarchonanthus camphoratus* (stunted, malformed, in consocieties in places); *Chilanthus arboreus* (much stunted); *Buddleia salviaefolia*. In opener sites between the shrubs appear *Elytropappus rhinocerotis*, *Stoebe* spp., *Passerina filiformis*, *P. vulgaris* (local); *Erica speciosa*, *E. canaliculata*, *Tetragonia* spp., *Mesembryanthemum* spp. and xerophytic grasses. Under the shrubs are societies of *Hypoestes* spp., *Barleria pungens*, *Blepharis* spp., *Justicia Bowiei*; *Rhinacanthus* sp., and *Knowltonia* spp., along with scattered *Haemanthus* spp., *Moraea iridioides* and *Pellaea* spp. *Aloe arborescens* is an important plant on the littoral, and occasionally occurs inland as well. *Podocarpus elongata* L'Herit., much gnarled and stunted, is to be found near water courses; *P. Thunbergii* Hook is much rarer.

The general physiognomy of scrub at the Knysna is much the same as that of the eastern Cape Province and of portions of Natal, except that the grotesque-shaped, candelabra tree—*enphorbias* (*E. grandidens*, *E. triangularis*, *E. tetragona*, etc.) are absent, as are the masses of succulent *Portulacaria afra*, *Crassula portulaca*, and introduced *Opuntia* spp. Conspicuous through their absence, too, are the following typical scrub forms of the eastern side: *Zizyphus mucronata*, *Ehretia hottentotica*, *Randia rudis*, *Acacia karroo*, *A. caffra*, *Schotia speciosa* (rare at Knysna), *Pappea capensis* (eastern portions of Knysna area), *Plectronia ciliata*, *Rhus mucronifolia*, *Tecomaria capensis*, *Plumbago capensis* (rare at Knysna), *Albuca Hookeriana* and *Sansevieria thyrsoiflora*. *Aloe* spp. are few, while the number of individuals present is small contrasted with the eastern scrub.

The absence of an abundance of grasses between the shrubby masses and along the scrub margins, and the presence of macchia plants in these positions, readily distinguish Knysna from eastern scrub.

Scrub forms occurring within the region, together with such stunted forest species that find a home in the community, are listed on pages 150–160.

#### (b) Bush.

Scrub usually develops in height, attains greater luxuriance, is invaded by typical forest species, and builds up bush. On the other hand, the *Psammophilous* macchia of the inland type may give rise to bush directly; the same is true of *Hygrophilous* macchia.

Bush differs from scrub primarily in its physiognomy—it assumes the aspect of what might be considered either *very luxuriant scrub* or *short, poorly-developed forest*. In a word, bush is the transition stage between scrub and forest. As would be expected of such a transition community, bush shows the presence of more and more forest species proper as its development proceeds. It shows the presence of *Podocarpus elongata* L'Herit. and of *P. Thunbergii* Hook. in fair numbers, while other important species appearing are *Apodytes dimidiata* (tree form, with thick, dark bark): *Ocotea bullata*: *Ilex*: *Gonioma Kamassi*: *Curtisia faginea*, *Scolopia Mundtii*: *S. Zeyheri* (both in tree form): *Olea lanrifolia* (a small tree): small trees of *Myrsine melanophloeos*, *Ekebergia capensis*, *Kiggelaria africana*, *Calodendron capense*, *Toddalia\* lanceolata*, *Celtis rhannifolia*, *Fagara Davyi*, *Rhus laevigata*, *Ficus capensis*, *Elaeodendron Kraussianum*, *E. croceum*, *E. capense*, *Mystroxydon spaerophyllum*, *Celastrus acuminatus*, *C. peduncularis*, and *Roxena lucida* occur.

The general height of the canopy ranges from twenty to thirty feet, the result being that a forest atmosphere—high humidity, low temperature, low light-intensity, low rate of evaporation—is produced. The edaphic factors—depth of soil, degree of soil moisture, humus content, total available soluble salts—are appreciably improved.

There is a general increase in numbers of species and of individuals of ferns, fungi, lianes, and epiphytes.

As in the instance of scrub, there are two well-defined types, the products of habitat influences: the littoral bush of the sea cliffs and the inland bush of the plateaux and foothills of the interior. The differences between the types are almost entirely structural, for the great majority of the species of the littoral type are found in the inland. The latter type is usually better grown, less gnarled, of greater rate of growth, and of greater luxuriance than the littoral type, principally owing to the fact that the littoral type is produced on drier soils and receives less actual rainfall.

Where either type mingles with the marginal members of forest proper, there are some really well-shaped, tall (thirty-five to forty feet high) trees of the best species, particularly of *Sideroxylon*, *Apodytes*, *Pterocelastrus*, *Ekebergia*, and *Myrsine*. Along the coast there is often a striking zonation as the sea is left: pioneer stages of the *Lithosere*, littoral scrub, littoral bush, littoral forest of shorter height than normal climax forest inland. Inland the zonation is usually less marked, owing to various complicating factors, chiefly differences in aspect, soil moisture, and soil depth, and to agents of disturbance.

As the species of the bush community are a mixture of scrub and of forest species, a special list of these is not necessary.

As exemplifying the extremely slow rate of growth in littoral bush, the data given in *Table XXXII* (p. 138) are interesting.

From bush of both types forest develops: on the coast the shorter, less luxuriant, drier type†; inland the taller, better-class types.

Bush developing in the *hydrosere* is usually capable of developing into a moister type of forest than bush developing either in the *psammosere* or in the *lithosere*.

On extreme sites—for example, on rocky, exposed sites on the coast, or on shallow-soiled, warm slopes inland—bush may remain as a subclimax for lengthy periods, probably several centuries.

\* *Vepris lanceolata* G. Don.

† *Vide* "Forest Types," Chapter VII.

Table XXXII.

ANNUAL GIRTH INCREMENT SHOWN BY THE 14 SPECIES OF TREES IN LITTORAL BUSH (10-200 FT. ELEVATION, NOETZIE BEACH.

Girth Classes.	Number of Trees Studied.	Species.	Period of Observation.	Girth Increment.
Inches.				Inches.
7-12.....	9	Podocarpus, Thunbergii, Hook....	1925-26	•0902
13-18.....	5	—	—	•2125
19-24.....	2	—	—	•0937
7-12.....	1	Podocarpus elongata, L'Herit.....	1925-26	•1875
13-18.....	1	—	—	•0625
19-24.....	4	—	—	•2812
31-36.....	1	—	—	•3750
37-42.....	1	—	—	•2500
43-48.....	1	—	—	•2500
7-12.....	1	Apodytes dimidiata.....	1925-26	Nil.
19-24.....	1	—	—	•3750
0- 6.....	1	Gonioma, Kamassi.....	1925-26	•1875
7-12.....	1	—	—	Nil.
0- 6.....	2	Pterocelastrus variabilis.....	1925-26	•1875
7-12.....	2	—	—	•1875
25-30.....	1	—	—	•0625
31-36.....	1	—	—	•1875
7-12.....	1	Elaeodendron croceum.....	1925-26	•0625
13-18.....	1	—	—	•2500
0- 6.....	2	Elaeodendron kraussianum.....	1925-26	•1250
7-12.....	7	—	—	•3572
19-24.....	1	—	—	•1875
0- 6.....	2	Myrsine melanophloeos.....	1925-26	•1562
19-24.....	1	—	—	•3125
13-18.....	1	Plectronia obovata.....	1925-26	•3125
7-12.....	2	Ochna arborea.....	1925-26	•0312
19-24.....	2	—	—	•0312
7-12.....	2	Royena pallens.....	1925-26	•2500
19-24.....	1	—	—	•3125
7-12.....	2	Euclea macrophylla.....	1925-26	•1250
0- 6.....	1	Olea foveolata.....	1925-26	•1875
7-12.....	5	—	—	•1375
7-12.....	2	Scelopia, Zeyheri.....	1925-26	•3125

The more important species found in scrub are given below. Many of these occur in bush as well, but in that community are associated with various forest species. For sake of easy reference, the Dicotyledonous families are listed alphabetically.

#### PHANEROGAMS.

##### 1. *Gymnosperms.*

The Taxaceae contain stunted individuals of the giant "Outeniqua," *Podocarpus elongata* L'Herit. (*P. falcatus* R.Br.) and of the "Upright Yellow-wood," *P. Thunbergii* Hook. (*P. latifolius* R.Br.).

*P. elongata*, showing a clear bole of about six feet in height and of about twelve feet in girth at breast height, are commonly found in littoral scrub. The crowns of such individuals are of considerable extent, but are developed in the direction of the prevailing sea wind. The boles, too, are seldom cylindrical, but are flattened on the sides exposed to sea winds.

The two species of *Podocarpus* fruit profusely in littoral scrub, but most of the fruits are non-viable, and few that are sound ever germinate. Regeneration of the species is very rare, and is very slow-growing.

The *Podocarpus* spp. do not occur in inland scrub, except along river and stream banks.

The small *Widdringtonia cupressoides* (Pinaceae) is to be found in both littoral and inland scrub, but sparingly, it being a plant favouring open macchia.

##### 2. *Angiosperms.*

###### (i) *Monocotyledons.*

The more important Monocotyledons of the scrub are : *Brunsvigia gigantea* (littoral), *Haemanthus albiflos*, *H. callosus*, *H. puniceus*, *Zantedeschia aethiopica*, *Cyanotis nodiflora*, *Wahlendorfia thyrsiflora*, *Ficinia* and *Tetraria* spp. (of drier soils), *Mariscus congestus*, *Carex aethiopica*, *Stenotaphrum glabrum* (open sites), *Moraea iridioides*, *Aristea pusilla*, *Antholyza caffra*, *Aloe arborescens* (chiefly littoral), *A. saponaria*, *A. latifolia*, *A. lineata*, *A. pluridens*, *A. striata*—chiefly inland; *Agapanthus umbellatus*, *Asparagus africanus*, *A. crispus*, *A. Thunbergianus*, *A. sarmentosus*, *A. medeoloides*, *Eriospermum* spp., *Gasteria* spp., *Haworthia* spp. (more karroid areas inland), *Kniphofia* spp., *Ornithogalum* spp., various orchids and several Restiaceae.

###### (ii) *Dicotyledons.*

##### *Acanthaceae.*

*Barleria pungens*, *Blepharis capensis*, *B. molluginifolia*, *Chaetacanthus Personii*, *Hypoestes aristata* (chiefly littoral), *H. verticillata*, *Isoglossa sylvatica*, *Justicia Bowiei*, *Rhinacanthus* sp. nov. (littoral), *Thunbergia capensis*—under shrubs, herbs, erect or decumbent, often in small sociies favouring the moister, more shaded portions in scrub.

##### *Aizoaceae.*

*Galenia africana*, woody shrub two to three feet high, common in dry, open scrub; *Mesembryanthemum* spp., chiefly *M. edule*, *M. acinaciforme*, *M. tenellum*, and about forty-eight other species, prostrate and fruticose, occur, principally on exposed sites in dry, inland scrub. *Pharnaceum dichotomum*, *P. distichum*, *Tetragonia fruticosa*, *T. decumbens*, are found on dry sites.

##### *Anacardiaceae.*

*Rhus crenata*, *R. dentata*, *R. excisa*, *R. incana*, *R. laevigata* (a stunted tree), *R. longispina*, *R. stenophylla*, *R. tomentosa*, *R. undulata*, *R. pubreula*, var. *fastigiata*, *R. Thunbergii*, *R. lucida*, *R. obovata*—woody shrubs to fifteen feet in height, much gnarled. *Laurophyllus capensis* (*Botryceras laurinum*) is to be found in inland scrub of moister nature.



The species of *Rhus* are most important plants of the scrub, providing dominants and subdominants for numerous small consocieties and small associates. They fruit profusely, but do not provide much regeneration.

#### *Apocynaceae.*

*Acokanthera venenata*: a woody shrub, often in consocieties; its flowers are showy in the mass, are sweet-scented, but decidedly poisonous. *A. venenata* var. *spectabilis* is recorded, but has not been seen. *Carissa ardnina*. *C. haematacarpa*\*: rigidly-armed shrubs.

#### *Asclepiadaceae.*

*Asclepias crispa*, *A. expansa*, *A. fruticosa*, *Astephanus marginatus*, *A. neglectus*, *Cynanchum africanum*, *C. capense*, *C. obtusifolium*, *Pachycarpus dealbatus*, *P. grandiflorus*, *Riocreuxia torulosa*, *Sarcostemma viminale*, *Schizoglossum cordifolium*, *S. heterophyllum*, *S. linifolium*, *S. tomentosum*, *S. aschersonianum*, *Secamone Alpini*, *Tylophora* sp., *Xysmalobium involucratum*, *X. undulatum*: sub-shrubs, herbs, and climbers, never very abundant in any one site, but fairly well distributed. *Stapelia variegata* and *S. verrucosa* occur on stony, exposed, semi-karroid sites.

#### *Araliaceae.*

*Cussonia thyrsoiflora* (woody scrambler), *C. spicata* (tree), toward the eastern limit.

#### *Bixaceae.*

*Dovyalis* (*Doryalis*) *longispina* (coastal, and toward east), *D. rhamnoides*: thorny shrubs, the latter species forming near the sea dense associates with other scrub shrubs; *Kiggelaria africana*, a variable and stunted tree; *Scolopia Zeyheri*: thorny, stunted tree; *Trimeria alnifolia*, shrub or small tree.

#### *Campanulaceae.*

*Lobelia spartioides* (inland), *L. hirsuta*, *L. tomentosa*, *L. erinus*, *Cyphia sylvatica*, *Wahlenbergia capillacea*, *W. procumbens*, *Lightfootia ciliata*, *L. undentata*: weak herbs.

#### *Capparidaceae.*

*Boscia caffra*: shrub, abundant on coasts; *Capparis citrifolia*, *C. Guenzii*: armed scramblers; *Nicnallria pedunculosa*, shrub. These plants are important members of the scrub, the *Capparis* spp. often forming impenetrable, thorny tangles.

#### *Caryophyllaceae.*

*Silene bellidioides*, *S. capensis*, *S. Burchellii*, *Cerastium capense*, herbs found in opener sites, especially in littoral scrub.

#### *Celastraceae.*

This is an important scrub family, providing dominants and subdominants for most of the scrub communities; most of the forms exhibit considerable variation. The fruit crops are poor, except in the instance of *Celastrus buxifolius* (*Gymnosporia buxifolia*).

*Cassine scandens*, *C. scandens* var. *latifolia*: scandent shrubs; *Celastrus acuminatus* (unarmed), *C. peduncularis* (stunted tree), *C. (Gymnosporia) polyacanthus* (inland), *C. procumbens* (prostrate, littoral), *C. cordatus* (coastal), *C. nemorosus* (armed), *C. buxifolius* (armed and very variable); *Elaeodendron croceum*, *E. capense*, *E. Kranssianum*: stunted trees; *Mystroxydon confertiflorum*, *M. sphaerophyllum*, *M. enclaeacforme*, *M. laurinum*, *M. apiculatum*:

\* To the east, and inland, only.

stunted trees or large shrubs ; *Pterocelastrus variabilis*, a stunted tree, *Putterlickia pyracantha* (armed scandent shrub) ; *Hartogia capensis* (shrub, frequent inland).

#### *Compositae.*

*Artemisia afra*, sub-shrub ; *Brachylaena neriifolia*, large shrub, along water-courses ; *Elytropappus rhinocerotis* : small shrub, very abundant on drier sites, an invader from the Karroo\* *Eriocephalus capitellatus* : small shrub, very abundant near coast ; *Gerbera* spp. (4) ; *Metalsia muricata*, sclerophyllous shrub ; *Mikania capensis*, climber ; *Osteospermum moniliferum*, *O. corymbosum*, *O. coriaceum*, *O. imbricatum* : shrubs of straggly nature ; *Stoebe cinerea*, shrub ; *Tarchonanthus camphoratus*, gnarled, stunted tree ; *Senecio mikanioides*, *S. quinquelobus*, *S. angulatus*, *S. deltoideus*, *S. macroglossa* : climbers.

#### *Convolvulaceae.*

*Cuscuta africana*, *C. appendiculata*, *C. cassytoides* : parasites on various scrub plants.

#### *Crassulaceae.*

*Cotyledon orbiculata*, *C. rhombifolia*, *C. ramosissima*, *Crassula lactea*, *C. fruticulosa*, *C. Harveyi*, *C. crenulata*, *C. rubricaulis*, *C. perfossa*, *C. tumita*, *C. rhomboidea*, *C. corymbulosa*, *C. rosularis*, *C. ericoides*, *C. sphaeritis*, *C. claviifolia*, *C. ciliata*, *C. crenulata*, *C. denticulata*, *C. obvallata*, and others : succulent undershrubs on stony, exposed sites.

#### *Cruciferae.*

*Heliophila* spp. (about five) : weak shrubs.

#### *Cucurbitaceae.*

*Melothria punctata*, *M. hederacea*, *Kedrostis nana* : climbers.

#### *Ebenaceae.*

*Euclea acutifolia*, *E. daphnoides*, *E. lanceolata*, *E. macrophylla*, *E. multiflora*, *E. polyandra*, *E. racemosa* : woody shrubs of varying size, entering abundantly into all scrub associates. *Royena glabra*, *R. cordata*, *R. hirsuta*, *R. lucida*, *R. pallens*, are important shrubs or stunted trees.

#### *Ericaceae.*

*Ericaceae* are found sparingly in scrub, the only species of importance being *Erica speciosa*, *E. canaliculata*, *E. caffra*, which form small communities on opener areas in moister localities.

#### *Euphorbiaceae.*

*Cluytia affinis*, *C. daphnoides*, *C. pulchella*, *C. alaternoides*, *C. ericoides*, *C. laxa*, *C. polifolia*, *C. pubescens*, *C. rubricaulis*, *Acalypha decumbens*, *A. glabrata*, *A. Ecklonii*, *Adenocline mercurialis*, *A. sessiliflora*, *A. humilis*, *A. serrata*, *Andrachne ovalis*, *Leidesia capensis* : shrubs or herbs ; *Ctenomeria cordata*, a twiner ; *Euphorbia elliptica*, *E. epicyparissias*, *E. ericoides*, and the exotic *E. helioscopia* and *E. peplus* are small herbs ; *Lachnostylis* is a large shrub or small tree.

*Cluytia pulchella*, *Acalypha glabrata*, *Lachnostylis capensis*, are important species entering many coastal and inland scrub communities. Inland *Cluytia* spp., *Adenocline* spp., *Acalypha* spp., *Leidesia*, and *Ctenomeria* occur, while the *Euphorbia* spp. found on the coast are also present, together with *E. clava*, *E. genistoides*, *E. Kraussiana*, *E. mauritanica*, and *E. pubiglands*. Succulent tree-euphorbias are found near the eastern limit of the region, in the district of Humansdorp, and then only here and there ; these are *E. grandidens*, *E. triangularis*, *E. tetragona*.

\* This plant requires observation as it is tending to increase in drier, fired sites.

*Gentianaceae.*

*Chironia baecifera* is the most widely spread Gentianaceous plant in scrub : it is a perennial with reduced leaves and divaricating branches, forming dense "elumps" ; while *C. jasminoides*, *C. peduncularis*, *C. melampyrifolia* occasionally occur in coastal scrub, they are more truly forest species ; *C. tetragona* favours the coastal scrub, as does *Orphium frutescens*. These plants are either biennial or perennial, lax herbs, with the exception of *Orphium frutescens*, which is a small perennial shrub. *Sebaea* spp. belong more naturally to moist areas and to forest, but sometimes *S. elongata*, *S. annea*, *S. crassulaefolia* are to be found ; these are small, weak annuals or biennials.

*Geraniaceae.*

*Geranium eanescens*, *G. ineanum*, *G. ornithopodum*, *Monsonia ovata*, *Pelargonium longifolium*, *P. dipetalum*, *P. lobatum*, *P. myrrhifolium*, *P. candicans*, *P. urbanum*, *P. iocastrum*, *P. peltatum*, *P. alehemilloides*, *P. laevigatum*, *P. divaricatum*, *P. zonale*, *P. reniforme*, *P. scabrum*, *P. capitatum*, *P. radula*, and others : small herbs and undershrubs, some of them semi-succulent.

*Icacinaceae.*

*Apodytes dimidiata* : tree much stunted and malformed ; *Cassinopsis capensis* : large, straggly, armed shrub, forming impenetrable thickets. *Pyrenacantha scandens* is a scrambler or liane.

*Labiatae.*

*Ballota africana*, *Leonotus leonurus*, *Plectranthus fruticosus* (damper portions only), *P. laxiflorus*, *P. Thunbergii*, *Salvia aurea* (littoral), *S. aurita*, *Stachys aethiopica*, *S. serrulata*, *S. Thunbergii*, *Teucrium africanum*, *T. capense* : herbs and herbaceous shrubs, seldom abundant.

*Leguminosae.*

*Acaea Karroo\** occurs as a rare plant in portions of Uniondale Division, and is frequent in the lower portion of the Humansdorp Division. *Borbonia lanceolata*, *Cassia tomentosa*, and *C. occidentalis* are locally abundant ; *Psoralea pinnata*, *P. spp.* ; *Sutherlandia frutescens* ; *Virgilia capensis* is a stunted tree in moister scrub near forest ; species of *Aspalathus*, *Argyrolobium*, *Crotalaria*, *Indigofera*, *Lessertia*, *Podalyria*, *Priestleya*, *Rhynchosia* occur, but belong more truly to mallee : *Sehottia latifolia* is found in coastal and inland scrub as a stunted shrub ; *S. speciosa* is rarer, both species increasing in numbers and luxuriance as the east is approached.

*Loganiaceae.*

*Buddleia salviaefolia*, *Chilianthus arboreus*, *C. dysophyllus* (east), are large shrubs or stunted trees of some importance in littoral scrub communities.

*Loranthaceae.*

Parasites on various woody shrubs and trees : *Viscum capense*, *V. rotundifolium*, *V. obscurum*. Where abundant, *Viscum* spp. do much harm to their hosts, ultimately killing them.

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\* A few plants introduced by oxen, sheep or goats from the Uniondale Division occur within the Knysna Division, at Diep River and Karatara.

*Malvaceae.*

Abutilon indicum, A. Sonneratum: Hibiscus aethiopicus, H. diversifolius, H. gossypinus, H. Ludwigii, H. pedunculatus, H. trionum, H. psyllus; Malvastrum calycinum, M. capense, M. tridactylites, M. divaricatum, M. grossulariaefolium, M. virgatum: Pavonia mollis, P. praemorsa; Sida triloba: soft-leaved fibrous shrubs favouring well-lighted areas in littoral and inland scrub.

*Meliaceae.*

Ekebergia capensis: stunted tree, variable, frequent in littoral scrub.

*Menispermaceae.*

Antizoma capensis, Cissampelos capensis: weak shrubs or climbers; C. torulosa, vine-like climber.

*Moraceae.*

Ficus capensis, a stunted tree or shrub, *cauliflorous*; F. Burt-Davyi, prostrate or semi-erect shrub; both species may be either *epiphytic* or *parasitic*.

*Myricaceae.*

Myrica cordifolia is entirely coastal; M. Burmanni, usually coastal; M. quercifolia, M. conifera, either coastal or inland: small woody shrubs of importance in pioneer littoral scrub as sand fixers.

*Myrsinaceae.*

Myrsina africana, woody shrub; M. melanophlos: a stunted tree, of considerable importance in littoral scrub.

*Ochnaceae.*

Ochna arborea, stunted tree: O. atropurpurea, coastal shrub.

*Oleaceae.*

Jasminum tortuosum \*(eastern limits), a climber; Olea capensis, large shrub; O. exasperata, small shrub (coastal); O. foveolata, large shrub; O. verrucosa (inland only), small tree. The Olea spp., except O. verrucosa, are of importance in scrub at the coast; O. verrucosa is a feature of inland scrub occurring on exposed, rocky "kopjes" and mountain sides.

*Oxalidaceae.*

The only important spp. in coastal and inland scrub are Oxalis purpurea, O. obtusa, O. punctata, and O. polyphylla.

*Papaveraceae.*

Papaver aculeatum†: annual herb on damper sites.

*Piperaceae.*

Peperomia reflexa, epiphytic on boles of stunted trees or shrubs in cooler, moister sites; Piper capense, a weak shrub, locally frequent.

*Pittosporaceae.*

Pittosporum viridiflorum, small tree or shrub, occasional in littoral scrub, more abundant in inland; fruits profusely.

*Plumbaginaceae.*

Plumbago capensis, a scandent shrub, local, coastal (e.g., at Plettenberg Bay, Keurbooms River, Buffalo Bay); possibly introduced from Humansdorp Division, but becoming naturalized.

\* *J. angulare* has been introduced at Wittedrift, in scrub.

† Exotic.

*Polygalaceae.*

*Mundtia spinosa*, an armed shrub, chiefly coastal : *Polygala myrtifolia*, a weak, woody shrub : *P. oppositifolia*, *P. pinifolia*, *P. virgata* : small shrubs.

*Primulaceae.*

*Samolus Valerandii*, *S. porosus* : fasciated herbs frequent at margins of coastal scrub.

*Proteaceae.*

These are more truly members of macchia, but several species linger in open scrub. *Leucadendron salignum* (large shrub), *L. eucalyptifolium* (large shrub), *L. aurantiacum* (small shrub), *L. adscendens* (small shrub), *L. strictum* (weak, small shrub), *L. Phillipsii* (medium-sized shrub, inland) : *Leucospermum conocarpum*, *Protea Mundtii*, *P. cynaroides*, *P. lacticolor*, *P. neriifolia* : fairly large shrubs.

*Ranunculaceae.*

*Clematis brachiata*\*, a woody liane : *Knowltonia daucifolia*, *K. glabri-carpellata*, *K. rigida*, *K. vasicatoria*, *K. brevistylis* : perennial herbs with rigid ternate leaves, particularly abundant in littoral scrub, where they form dense ground socies.

*Rhamnaceae.*

*Phylica* spp. are macchia plants, but on occasion relicts are found in scrub : *P. lasiocarpa*, *P. paniculata*, *P. verticillata*, *P. axillaris*. *Noltea africana*, a shrub ten to fifteen feet high, is found near water, inland and to the east. *Rhamnus prinoides*, a bushy shrub with dense foliage, forms consocies : *Scutia Commersonii* (*S. indica*) is an armed scandent.

*Rosaceae.*

*Cliffortia* spp. are really macchia plants, but occasionally *Cliffortia falcata*, *C. filifolia*, *C. juniperina*, *C. linearifolia*, *C. iliciflora*, *C. octandra*, occur in open areas in scrub, as do *Rubus pinnatus*, *R. rigidus*, and the naturalized exotic *R. fruticosus*.

*Rubiaceae.*

*Burchellia capensis*, large woody shrub : *Galium glabrum*, *G. asperum* : weak, flexuous herbs : *Galopina circacoides*, procumbent herb : *Plectronia Mundtii*, *P. obovata* : stunted trees : *P. ventosa*, *P. spinosa* : armed woody shrubs : all the species of *Plectronia* are important constituents of littoral and inland scrub : *Rubia petiolaris* is an erect coastal scrub herb.

*Rutaceae.*

*Calodendron capense*, stunted tree, deciduous : *Clausena inaqualis*, small woody shrub : *Vespris* (*Toddalia*) *lanceolata*, stunted tree : *Fagara capense*, small stunted shrub : *F. Davyi*, stunted tree : *Barosma scoparia* occurs in littoral scrub : *Empleurum serrulatum*, a tall shrub, favours scrub along water-courses.

*Salvadoraceae.*

*Azima tetracantha*, armed shrub, rare along coast, but more frequent inland and toward the east. It fruits profusely, but practically no birds or mammals touch these. (*Colius striatus*, the "Muisvogel," occasionally partakes of the white fruits, and as a result its flesh tastes bitter.)

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\* Including *Clematis Thunbergii* Steud.

*Santalaceae.*

*Osyris abyssinica*, woody shrub, forming consociés inland and on coast; *Rhoicarpus capensis*, also a woody shrub, is far less frequent\*; *Thesium* and *Thesidium* spp., semi-parasitic shrublets and herbs, are frequent, there being about twenty-five species of *Thesium* and three of *Thesidium*.

*Sapindaceae.*

*Aitonia capensis*, woody shrub with showy fruits, is occasional in the north of the region; *Allophyllus decipiens* (*Schmidelia decipiens*), *A. erosus* (*S. erosus*): small trees or large shrubs, very frequent in littoral scrub; *Dodonaea Thunbergiana* is a woody shrub frequent inland: it has showy fruits; *Hippobromus alata* occurs towards the east, but is much stunted. (A few larger specimens grow in the Keurbooms River Scrub Forest Reserve.)

*Sapotaceae.*

*Sideroxylon inerme*, stunted, malformed tree, especially frequent on the coast, where it forms important consociés and associates.

*Serophulariaceae.*

*Freylinia undulata*, woody shrub in inland scrub; *Halleria lucida*, stunted tree or large shrub, widely distributed, but never very abundant in scrub; *Harveya* spp. occasionally occur as parasites on *Erica* and *Phyllica* in open scrub; species of *Melasma*, *Nemesia*, and *Sutera* are also present, but are of little ecological importance.

*Solanaceae.*

*Datura stramonium*, ruderal shrub is frequent near human habitations, but is being eradicated; *Lycium austrinum* (unarmed), *L. campanulatum*, *L. tetrandum* (armed): woody shrubs forming dense thickets†; *Nicotiana glauca*, possibly exotic, widely spread in open scrub; *Physalis minima*, *P. (peruviana) pubescens*, are frequent in moister scrub; *Solanum aggerum* (prostrate coastal shrub), *S. aculeastrum*, *S. aculeatissimum*, *S. capense*, *S. coccinium*, *S. giganteum*, *S. rigescens*, *S. sodomaicum*, *S. tomentosum*: armed shrubs, varying from two to twelve feet in height; *S. quadrangulare* is an unarmed coastal climber, *S. nigrum* a naturalized undershrub, *S. pseudocapsicum*, a naturalized shrub bearing showy red fruits: the *Solanaceae* favour open sites in scrub, although *S. giganteum* can withstand dense shade.

*Stereuliaceae.*

*Hermannia* spp. occasionally occur in open inland scrub, especially *H. leucophylla*, *H. salviaefolia*, *H. flammea*, *H. hyssopifolia*: small herbs and shrubs.

*Thymeleaceae.*

*Gnidia denudata*, *G. oppositifolia*, *Passerina filiformis*, *P. vulgaris* (coastal), *P. falcifolia*, and *Struthiola striata* are the commonest representatives, often found in open scrub.

*Tiliaceae.*

*Grewia occidentalis* is a common scandent shrub.

*Ulmaceae.*

*Celtis rhamnifolia* occurs in inland and littoral scrub, chiefly along river banks; it is a stunted, deciduous tree.

\* Towards east, only.

† Particularly on saline soils.

*Umbelliferac.*

*Heteromorpha arboreseens*, variable woody shrub, with polymorphic foliage; *Peucedanum capense*, small shrub; *P. capillaceum*, *P. ferulaeum*: herbs with aerid foliage. *Hydrocotyle* spp. are frequent along stream banks.

*Urticaceae.*

*Fleurya mitis*, herbaceous, with urticating hairs; *Urtica urens*, is a widely-spread, naturalized exotic; *Droguetia ambigua*, herb.

*Verbenaceae.*

*Verbena bonariensis*, exotic herb, to eight feet in height, frequent in open scrub; *Lantana salviaefolia*, a small semi-woody shrub, is found in scrub on the eastern limits of the region.

*Vitaceae.*

*Rhoicissus capensis*, *R. digitata*, *R. cirrhosa*, and *Cissus euneifolia* are vine-like twiners of considerable importance in scrub, binding together the crowns of the stunted trees and shrubs.

*Zygophyllaceae.*

*Zygophyllum flexuosum*, *Z. fulvum*, *Z. morgsana*: small shrubs frequent in littoral scrub.

*Ferns.*

These are rare, the only widespread spp. being: *Cheilanthes hirta* v. *construeta*, *Pellaea quadripinnata*, *P. viridis*, *Blechnum tabulare*, *Aspidium capense* (stunted form), *Asplenium bipinnatum* (often epiphytic), *Polypodium lanceolatum* (often epiphytic).

## Chapter VI.

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THE CLIMAX HIGH FORESTS: FLORISTIC  
FEATURES.





## CHAPTER VI.

## THE CLIMAX HIGH FORESTS—FLORISTIC FEATURES.

In comparison with the species of the macchia, forest plants proper are few. The principal forest plants are listed below, commencing with the Phanerogams.

## PHANEROGAMS.

1. *Gymnosperms.*

The Taxaceae are represented by *Podocarpus elongata* L'Herit. (*P. falcatus*, R.Br.), and *P. Thunbergii* Hook. (*P. latifolius* R. Br.). These trees play a most important part in the life-history of the forest.

*P. elongata* is the giant tree of South African forests, but is rarely abundant in one and the same locality (*vide* *Podocarpus elongata* consociation), it appears scattered throughout the forests.

*P. Thunbergii*, forming the true second story of the forest canopy, is either abundant or frequent in most forest communities.

*Widdringtonia cupressoides*, a small, badly grown tree, although more plentiful in certain portions of the macchia, may occasionally be found just within the forest margins.

2. *Angiosperms.*(i) *Monocotyledons.*

The principal Monocotyledons normally found in climax forest are:—*Haemanthus puniceus*, *H. albiflos* (coastal). *Vallota purpurea* (in dense societies, producing a riot of scarlet in the flowering season, January to February), *Carex aethiopica*, *Cyperus tenellus* (in very dense societies on very moist sites), *Ficinia capillifolia* (very moist sites), *F. leiocarpa* (dry sites), *F. sylvatica*, *Mariscus congestus* (widespread, but more abundant on moist sites), *Rhynchospora* sp. nov. (very moist sites), *Schoenoxiphium lanceum*, *S. sparteum* (medium moist sites), *Scirpus prolifer* (very moist sites), *Tetraria sylvatica*, *Stenotaphrum glabrum*, *Oplismenus africanus*, *Aristea pusilla*, *Moraea iridioides* (drier sites), *Juncus lomatoophyllus* (moist sites), *J. oxycarpus*, *Prionium palmita* (along river beds), *Agapanthus umbrellatus* (drier forests, montane and coastal), *Asparagus africanus*, *A. crispus* (armed climbers), *Asparagus plumosus*, *A. scandens* (climbers), *Chlorophytum comosum*, *Strelitzia augusta* (rare west of Keurbooms River, frequent east of that river), *Calanthe natalensis* (terrestrial or epiphytic), *Acrolophia cochlearis*, and the epiphytes, *Listrostachys arcuata*, *Angraecum bicaudatum*, *A. Burchellii*, *A. conchiferum*, *A. pusillum*, *A. sacciferum*, *Mystacidium flicorne*, *Polystachya Ottoniana*. *Bonatea speciosa* occurs on opener moist sites, as occur *Disa micrantha*, *D. cornuta*, *Disperis capensis*, *Satyrium retusum*, *S. bracteatum*, *Holothrix squamulosa*.

*Zantedeschia aethiopica* (*Richardia africana*) forms large consocieties and sociies on moist, open sites, and smaller societies in moist, dark forest. A feature of moist, open sites is *Wachendorfia thyrsiflora*.

(ii) *Dicotyledons.*

The principal Dicotyledons commonly found in the forests are listed below—the families being arranged alphabetically:—

*Acanthaceae.*

*Hypoestes verticillata* forms extensive societies in drier forests. *Isoglossa sylvatica* is locally frequent.

*Anacardiaceae.*

*Rhus laevigata* (small tree, frequent in coastal and montane forest); *R. lucida* (large shrub, widespread); *R. incana*, *R. tomentosa* (medium-sized shrubs) occasionally occur in forest; the other *Rhus* spp. are not usually found in forest, being frequent in scrub and bush. *Botryceras laurinum* (*Laurophyllus capensis*) is a common, untidy woody shrub of the margins.

*Apocynaceae.*

*Carissa arduina* (small armed shrub, occasionally assuming a scandent habit); *Gonioma Kamassi* (small, but very valuable timber tree, occurs in all forests of the region, and in certain coastal forests as far east as East London, but does not occur at Alexandria\*); *Aeokanthera venenata* (medium-sized, woody shrub with poisonous latex and fruits, is rare in forests except certain coastal and montane ones).

*Aquifoliaceae.*

*Ilex* (capensis) *mitis* (large tree, frequent in moist sites).

*Asclepiadaceae.*

*Secamone Alpini* (liane forming thick woody stems rich in latex, much sought for food by elephants); *Cynanchum obtusifolium* (twiner), *C. capense* (twiner); *Sarcostenima viminale* (leafless, succulent twiner); *Tylophora syringaeifolia* (twiner), *T. sp.* (twiner); *Astephanus marginatus* and *A. neglectus* are twiners. Although the number of species is small, the Asclepiadaceous lianes and twiners play an important part, in that they are abundantly developed, and knit together the branches and foliage of trees and shrubs into almost impenetrable tangles. They inhibit the growth and development of large numbers of young trees.

*Araliaceae.*

*Cussonia thyrsiflora*, occasionally grows in drier forest, as a weak, scandent shrub. *C. umbellifera* occurs in several forests (Witte Els Bosch Forest Reserve) on the upland plateau, in the district of Humansdorp. The trees are abundant in these forests, and assume full heights of from 40 to 50 feet, with clean boles of from 15 to 25 feet: they are from 10 to 20 inches in diameter when mature. Occasionally, small consociations are found, but usually the species is mixed with the usual forest trees. *Apart from this occurrence at Witte Els Bosch, C. umbellifera is not known to occur west of the St. John's River.*

*Balsaminaceae.*

*Impatiens capensis* (delicate herb, forming dense societies in cool, moist sites); *I. Duthiei* (occurs sparingly in moist forests, forming small societies, or mixed with *I. capensis*).

*Bixaceae.*

*Dovyalis* (*Doryalis*) *rhamnoides* (armed woody shrub, more frequent in drier forests: often in small societies. The fruits are edible); *Kiggelaria africana* (medium-sized timber tree, varying much in leaf-form, according to locality, the leaves being larger and thinner in the inland forests, smaller and thicker and pubescent on the ventral surfaces, in the coastal); *Scolopia Mundtii* (small to medium-sized timber tree, locally frequent, but on the whole, a rare species. The boles may be either entirely unarmed or may show strongly

\* Recently recorded from the Mkandhla Forests, Zululand.

developed spines): *S. Zeyheri*\* (very rare in the climax forests, a strongly armed tree of small dimensions): *Trimeria alnifolia* (small tree or large shrub); *T. trinervis* (shrub) has been recorded, but the writer has never seen this (*vide* Schonland, 1922†).

#### *Campanulaceae.*

*Lobelia* spp. occurs in lighter, moister sites, especially *L. hirsuta*, *L. anceps*, *L. erinus* var. *bellidifolia*, *L. patula*, *L. tomentosa*: *Wahlenbergia procumbens* is frequent on moist sites. *Lightfootia fasciculata*.

#### *Capparidaceae.*

*Capparis citrifolia* (armed, scandent shrub, frequent in dry forest; at times clambers to the crowns of *Podocarpus elongata* L'Herit.).

*Niebuhria* (*Maerua*) *pedunculosa* rarely occurs.

#### *Celastraceae.*

*Cassine scandens* (small, scandent shrub, frequent in drier forest, rare in main forests); *Celastrus acuminatus* (medium-sized timber tree, foliage very variable, according to locality); *C. peduncularis* (medium-sized timber tree); *C. luxifolius* and *C. nemorosus* (armed woody shrubs, leaves variable according to locality); *Elaeodendron croceum* (medium-sized tree); *Elaeodendron capense* (small tree); *Elaeodendron Kraussianum* (small to medium-sized timber tree, more common in coastal and montane forests of drier nature); *Pterocelastrus variabilis* var. *variabilis* (frequent throughout the forests, a medium-sized to large timber tree, may occur in consocieties and consociations); *Pterocelastrus variabilis* var. *rostratus* is recorded from the George mountain forests‡ (*vide* Schonland, 1922, op. cit.): *Hartogia capensis* is a shrub to fifteen feet, frequent along the margins of many forests.

#### *Cornaceae.*

*Curtisia faginea*, the sole representative, is an important, medium-sized to large timber tree, frequent throughout the forests. [*vide* Phillips, 1928; (4)].

#### *Cucurbitaceae.*

*Melothria* (*Zehneria*) *obtusiloba*, *M. hederacea*, *M. punctata* are twiners, binding together the branches of the shrub layers.

#### *Cunoniaceae.*

*Cunonia capensis* is a large timber tree very abundant in moist forests on the plateaux and in the mountains: it is often associated with *Platylophus*. *Platylophus trifolius* is an endemic monotype—a large timber tree, usually in consocieties, or in assosciates with *Cunonia* as the other dominant [*vide* Phillips, J. F.; 1925; (i)].

#### *Droseraceae.*

*Drosera cuneifolia*, an insectivorous herb, is frequent in moist sites.

#### *Ebenaceae.*

The only forest plants are:—*Euclea lanceolata* (shrub, scattered in littoral and montane forest); *E. macrophylla* (shrub or small tree, frequent in drier forest); *Royena glabra* (small shrub, frequent along margins); *R. lucida* (a medium-sized tree); *R. pallens* (variable shrub or small tree, common in drier forests).

\* Locally frequent in certain coastal forests.

† Manuscript preliminary check list, Vols. I-III, Flora Capensis.

‡ 1926.: This species has been collected from all the larger forests west of George by the writer.

### *Ericaceae.*

The Ericaceae are frequent in burned and heavily exploited forest, but are not members of forest proper. The large *E. canaliculata* may be found in medial seral stages.

### *Compositae.*

The only trees are : *Brachylaena dentata* (does not occur further west than Witte Klips Forest, a few miles west of Storms River : a small to medium-sized tree) : *B. neriifolia* (along river beds and on other moist sites, usually in consocieties : a large shrub or small tree) : *Tarchonanthus camphoratus* (a small to medium-sized tree, usually commoner in coastal and montane forests). *B. discolor* is recorded from Storms River Pass, but has not been collected by the writer.

The more important larger, woody shrubs found on disturbed areas within the forests are :—*Euryops virgineus*, *Metalsia muricata*, *Osteospermum corymbosum*, *O. moniliferum*, which form dense communities.

Smaller composites commonly found are :—*Aster* spp. (ruderal) : *Athanasia* spp. (ruderal) : *Bidens pilosa* (mainly ruderal) : *Cryptostemma calendulaceum* (ruderal) : *Dichrocephala latifolia* (ruderal on moist sites) : *Elytropappus rhinocerotis* (on drier sites only, ruderal) : *Euryops abrotanifolius* var. *intermedia* (drier sites) : *Gerbera cordata*, *G. piloselloides*, *Helichrysum* spp. (chiefly *H. cynosum*, *H. felinum*, *H. foetidum*, *H. parviflorum*, *H. petiolatum* (a rampant weed on most disturbed sites)) : *Helipterum eximium*, *Hippia frutescens* (rampant weed on burnt sites) : *Hypochoeris radicata* (ruderal) : *Leontonyx squarrosa*, *Peyrousea calycina*, *Senecio crenatus*, *S. glastifolius*, *S. ilicifolius*, *S. juniperinus*, *S. lyratus*, *S. lineatus* : *Sonchus oleraceus* (ruderal) : *Stoebe alopecuroides* (disturbed sites only) : *S. cinerea* (usually burnt sites) : *Ursinia anthemoides*, *Xanthium spinosum* (ruderal) : *Osmites bellidiastrum* (moist sites).

Lianes commonly found are :—*Senecio angulatus*, *S. deltoideus* (eastern portion of region) : *S. quinquelobus*, *S. mikanioides*, *Mikania capensis*, *Vernonia anisochaetoides*.

Apart from the influence of such rampant weeds as *Helichrysum* and *Bidens* upon regeneration of tree species, the Composites are relatively unimportant in the forests.

### *Euphorbiaceae.*

*Cluytia pulchella* (large shrub to fifteen feet in height) : *C. affinis*, *C. alaternoides*, *C. daphnoides*, *C. ericoides*, *C. laxa*, *C. polifolia*, *C. rubricaulis* (smaller woody shrubs) : the *Cluytias* are more frequent in disturbed forest than in natural : they form dense communities useful as nurse stands to seedling trees. *Ctenomeria capensis* (twiner) : *Acalypha decumbens*, *A. glabrata*, *A. Ecklonii* : *Adenocline mercurialis* (shrubs). The monotypic small tree, *Lachnostylis capensis*, is frequent throughout the drier forests : its leaves are very variable in size and shape, according to sex of tree and factors of the locality. *Sapium Simii* is a small shrub, frequent in dry coastal forests.

### *Gentianaceae.*

*Chironia jasminoides*, *C. malampyrifolia*, *C. peduncularis* are perennial herbs, frequent under lighter canopy. *Sebaea Grisebachiana*, *S. Brehmeri* are annual or biennial herbs, in open sites.

### *Geraniaceae.*

These rarely occur in normal forest : several *Pelargonium* spp. are found in disturbed portions, being introduced by cattle.

*Gesneraceae.*

*Streptocarpus Rexii* (perennial herb, either epiphytic or terrestrial).

*Guttiferae.*

*Hypericum aethiopicum* occasionally is found under lighter canopy, and along the margins.

*Halorrhagaceae.*

*Laurembergia* (*Serpicula*) *repens* (small herb, forming dense ground societies on moist ground); *Gunnera perpensa* (small, large-leaved herb, usually in moist places: pure or mixed with *Laurembergia*).

*Hamamelidaceae.*

*Trichocladus crinitus* (wide-spread woody shrub to eighteen feet in height, forming dense layer societies in medium-moist and dry forests): *Trichocladus ellipticus* (a common shrub of the eastern forests, but rare in the Knysna; occurs at Sourflats and at Gouna—sparingly).\*

*Icacinaceae.*

*Apodytes dimidiata* (a large and important timber tree, present in most forest communities: is best developed in moist forest): *Cassinopsis capensis* (armed scandent shrub, most frequent in dry, open forest).

*Pyrenacantha scandens* is frequent in dry forests: it is a troublesome binder of under growth.

*Labiatae.*

*Plectranthus fruticosus* forms dense societies from two to four feet in height, in moist forest; *P. Thunbergii* is less frequent, and smaller. *Stachys Thunbergii*, a hispid, untidy Rambler, forms small societies.

*Lauraceae.*

*Cassytha ciliolata* (parasitic twiner, with leaves reduced to scales, uniseriate haustoria, and no chlorophyll: attacks various hosts, notably, among trees, *Virgilia capensis* and *Ocotea bullata*): *Ocotea bullata* (large and most valuable timber tree: occurs on occasion in small consociations, but is usually mixed with other tree species: develops best in moist forests: coppices freely).†

*Leguminosae.*

*Cassia occidentalis*, *C. tomentosa*, small trees or large shrubs, frequent in consociates, or associates, usually in open forest: these are exotics in all probability. *Crotalaria* spp.‡, *Podalyria* spp., *Psoralea* spp. occasionally grow in open forests, but do not belong to the forest flora proper. *Schotia latifolia* is a rare, small tree in coastal forest in the Zitzikamma and near Plettenberg Bay. *S. speciosa* is recorded from the same localities, but has not been seen there.

*Trifolium repens* is a widely spread exotic in all forests that have been exploited or grazed. *Dolichos gibbosus* is a poisonous climber, frequent in open forest: *Egelia bituminosa* is a common twiner in coastal forest: *Virgilia capensis*, a tree from 20 to 60 feet high and from 6 to 24 inches in diameter, rarely occurs in high forest, but is frequent in late seral stages. *Erythrina caffra* reaches the Kromme River forests in the Zitzikamma.

*Lentibulariaceae.*

*Utricularia capensis*, a delicate herb, grows on moss cushions in moist forests.

\* About 6 individuals in all are known to the writer.

† *Vide* Phillips, 1924 (1).

‡ Especially *Crotalaria purpurea*.

*Loganiaceae.*

*Buddleia salviaefolia* (small, badly shaped tree, frequent in seral stages); *Chilianthus arboreus* (small tree more common in the coastal forests); *Nuxia floribunda* (medium to large, badly shaped tree, frequent in medium-moist and moist forest).

*Strychnos Atherstonei* is recorded from the extreme east of the region, in the Humansdorp Division, but has not been seen by the writer.

*Loranthaceae.*

*Viscum obscurum* (chiefly parasitic on *Olea laurifolia* and *Platylophus trifolius*).

*Lythraceae.*

*Lythrum hyssopifolium* (frequent in moist places under light canopy: not a forest plant proper, but introduced).

*Malvaceae.*

*Abutilon Sonneratianum*, *Malvastrum calycinum*, *Pavonia mollis*, *Sida triloba* (small fibrous shrubs) occur, but *Malvaceae* are better represented in littoral scrub and bush. (*Hibiscus pedunculatus* is locally frequent in dry forests.)

*Meliaceae.*

*Ekebergia capensis* (medium to large forest tree, more frequent in coastal forest, where it may be found in consocieties: in the main forests it is scattered) this species varies much in the form of its leaflets. [*Vide* Phillips, 1927: (4).]

*Menispermaceae.*

*Antizoma capensis*, *Cissampelos torulosa*, are twiners occasionally found in high forest.

*Moraceae.*

*Ficus capensis* (*cauliflorous*, small to medium-sized tree, or weak, scandent shrub, sometimes *epiphytic-parasitic\** on other trees): *F. Burt-Davyi* (similar in its growth-forms to the former species), is more frequent in the Zitzikamma Forests and in the coastal forests.

*Myricaceae.*

*Myrica conifera* (small shrub, occurs sparingly in coastal and montane forests).

*Myrsinaceae.*

*Myrsine africana* (marginal shrub or very small tree: more frequent in coastal and montane forests); *M. melanophleas* (medium to large tree, often in consocieties: may form associations with any other forest trees: is an important species in the penultimate seral stages).

*Ochnaceae.*

*Ochna arborea* (small tree); *O. atropurpurea* (shrub, rare in the main, but frequent in the coastal forests).

*Oleaceae.*

*Olea capensis* (large shrub or small tree); *O. foveolata* (small tree); *O. laurifolia* (large tree, frequent in most forests, but varying much in size and development according to locality; with *Podocarpus Thunbergii* Hook, one of the most important species of the forests).

\* i.e. commences life as an *epiphyte*, but gradually assumes the rôle of a *parasite*.

*Oliniaceae.*

*Olinia cymosa* (medium to large tree, found in consocieties and associates; is especially frequent in drier forests; for details of biology *vide* J. F. Phillips, 1926; (i)).

*Oxalidaceae.*

*Oxalis convexula*, *O. incarnata* are the most important forest species in this family.

*Piperaceae.*

*Peperomia reflexa*, *P. retusa* (epiphytic or terrestrial, perennial herbs); *Piper capense* (lax shrub, frequent in moist forests).

*Pittosporaceae.*

*Pittosporum viridiflorum* is scattered in coastal and montane, but does not occur in normal forest, except in several patches at Jonkersburg, twenty miles west of George.

*Polygalaceae.*

*Polygala myrtifolia* (large, weak shrub, frequent in coastal forest: occasional on open sites in main forests); the smaller *P. oppositifolia* occurs in like localities.

*Polygonaceae.*

*Polygonum acuminatum* var. *capense* (herb, in moist places); *P. senegalense* (tall shrub, frequent in disturbed forest; probably an exotic); *Rumex acetosella* is a widely spread exotic, in moist sites; *R. sagittatus* is a handsome climber, frequent in open sites.

*Proteaceae.*

Large *Protea* and *Leucadendron* species, e.g., *P. Mundtii*, *P. laticolor*, *L. eucalyptifolium*, *L. salignum*, occasionally grow in medial and penultimate stages, but are not present in climax forest.

*Faurea McNaughtonii*,\* a large timber tree is found in one forest only, that of "Lilyvlei," Gouna Reserve, Knysna Division: in this locality the trees are very abundant, and the regeneration of all stages excellent.

*Faurea* is another example of discontinuous distribution—it being known from several widely separated Transkeian forests, and from one forest in Natal only, apart from its occurrence at Gouna.

*Ranunculaceae.*

*Clematis brachiata* (a woody liane, abundant throughout the forests: much sought for food by elephant; *Knowltonia glabricarpellata*, *K. rigida*, *K. vesicatoria* (rigid, herbaceous shrubs, forming layers from one to three feet high, especially in drier forests); *Ranunculus pinnatus* (herb, very common in moist places, forming small ground-societies); several exotic species of *Ranunculus* are to be found in forest, occasionally.

*Rhamnaceae.*

*Rhamnus prinoides* (small or large woody shrub, frequent under lighter canopy); *Scutia indica* (*S. Commersonii*) is a troublesome, armed, scandent shrub which often takes the form of a woody liane and strangles young and old trees.

\* *Vide* J. F. Phillips, 1927 (1).



*Rosaceae.*

*Cliffortia odorata* (a prostrate, herbaceous shrub, forming dense communities under open canopy, in moist sites: is also abundant along the margins: when virile, forms an excellent natural fire-resister); *Pygeum africanum* (a large timber tree, occurs as a rarity in the Blaauwkrantz Pass Forest\*); *Rubus fruticosus* [introduced into the Storms River Forest in 1856, has since spread throughout the region, forming impenetrable communities from three to over ten feet in height wherever sufficient light is available: it has been spread by human and lower animal (especially elephant in the Knysna Division) agencies]; *R. pinnatus* is a weak Rambler, able to grow under low light-intensities: *R. rigidus*, so common in scrub, is rare in high forest.

*Rubiaceae.*

*Anthospermum aethiopicum*, *A. ciliare* (herbs, occasionally found inside the forests); *Burchellia capensis* (large woody shrub or small tree: a prominent member of the lower tree layers in high forest); *Galopina circacoides* (weak herb, frequent throughout the forests); *Gardenia Rothmannia* (small tree, scattered, in drier forests, produces a showy, sweetly scented flower); *Plectronia Mundtii* (small tree); *P. obovata* (medium-sized tree, with marked buttresses and flutings); *P. ventosa* (a spiny, woody shrub, frequent in drier, opener forests); *P. spinosa* (of the same habit as the former plant: occurs sparingly, but increases as the eastern limit of the region is approached); *Psychotria capensis* (large shrub, found in "Lilyvlei" Forest, Gouna Reserve, Knysna Division, only, in the region under description, but well represented in the eastern and Natal forests). (*Plectronia pauciflora* Klotz.—Flora Cap., III; 18—has not been collected.)

*Rutaceae.*

*Calodendron capense* (medium tree, rare in main, frequent in coastal forests: produces mauve, rhododendron-like flowers); *Clausena inaequalis* (weak shrub, occurs in drier coastal and inland forests); *Fagara capense* (small tree or large shrub, chiefly in coastal forests); *F. Davyi* (tree, occasional in main forests, but common in coastal); *Empleurum serrulatum* (shrub to twenty feet in height, frequent along rivers, and at higher altitudes). *Toddalia (vepris) lanceolata*, a small tree, occurs sparingly.

*Santalaceae.*

*Osyris Abyssinica*; (*Colpoen compressum*), is frequent in open sites in coastal and montane forests, but rarely grows in the main forests.

*Sapindaceae.*

The only forms occurring in forests are:—The large woody shrubs or small trees *Allophylus* (*Schmidelia*) *deeptiens*; *A. crosus* (*Schmidelia crosa*); *Hippobromus alata* (east of Keurbooms River).

*Sapotaceae.*

*Sideroxylon inerme* (medium-sized tree, or badly shaped shrub, frequent in coastal and montane forest, very rare in main forests).

*Scrophulariaceae.*

*Halleria lucida* (small tree or large shrub, often in cousoesies, on lighter-canopied sites: is a member of the lower tree layers: cauliflory is exhibited); *Melasma sessiliflorum* (herb, parasitic on shrub roots: rare in forests); *Sutera* spp. (procumbent herbs; frequent in moist, opener sites).

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\* About 20 trees have been located by the writer. 1926.

*Solanaceae.*

*Physalis* (peruviana) pubescens (exotic, herbaceous shrub, occurs sparingly in open forest); *Solanum giganteum* (a shrub to fifteen feet in height); *S. nigrum* (herbaceous climber); *S. aculeastrum*, *S. sodomaeum*, *S. tomentosum* (spiny shrubs, exotics); the *Solanaceae* are either exotics or ruderals, introduced to the forests by elephant and cattle.

*Thymeleaceae.*

*Gnidia denudata* (fibrous shrub, frequent along elephant paths); *Passerina falcifolia* (shrub to fifteen feet in height, frequent along margins); *P. filiformis* (shrub to ten feet), locally frequent in drier forests.

*Tiliaceae.*

*Grewia occidentalis* (woody climber, rare in main forests, but frequent in coastal and montane forests).

*Sparmannia africana* (an important, fibre-producing shrub, attaining heights of from ten to fifteen feet).

*Ulmaceae.*

*Celtis rhamnifolia* (medium-sized tree, frequent along rivers).

*Umbelliferae.*

*Heteromorpha arborescens* (large shrub, with variable leaves, frequent in coastal and montane forests); *Hydrocotyle asiatica* (herb, frequent in moist places).

*Urticaceae.*

*Fleurya mitis* (herb, with urticating hairs; locally frequent); *Urtica aurea* (locally frequent; exotic).

*Vitaceae.*

The vine-like climbers, *Rhoicissus capensis*, *R. digitata*, *Cissus cuneifolia* are frequent in coast, disturbed main, and montane forests; *R. capensis* is detrimental to crown-development of many young trees.

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 CRYPTOGAMS.
1. *Pteridophytes.*

The more important forest ferns listed are:—*Trichomanes pyxidiferum* (moist banks and tree trunks); *Hymenophyllum tunbridgense* (moist banks and tree trunks); *Hemitelia capensis* (ten to twelve feet high, forming extensive layer-societies in moist forest); *Dryopteris Bergiana*, *D. africana*, *D. lanuginosa* (small ferns of moist sites); *Polystichum aculeatum*, *P. pungens*, *P. adiantiforme* (hardy ferns several feet high, found on drier soils); *Asplenium monanthes*; *A. lunulatum*; *A. protensum*; *A. gemmiferum* (this plant is often epiphytic); *A. bipinnatum* (this plant is often epiphytic); *A. theciferum*; *A. cuneatum*\*; *A. praemorsum*; *A. solidum*. *Blechnum australe*, *attenuatum*; *B. punctulatum*; *B. tabulare*† (ferns frequently on drier soils); *B. capense* (frequently on moist sites). *Pellaea quadri-pinnata*; *P. viridis* (drier sites). *Cheilanthes hirta* (dense shade); *Hypolepis sparsiora*; *H. Bergiana* (moist sites); *Adiantum capillus-veneris* (local; along stream-banks); *Pteris cretica*; *P. Buchananii* (these are frequent in moist sites). *Lonchitis pubescens* (humid sites). *Pteridium aquilinum* (widespread, but best developed where light is strong).

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\* Sometimes epiphytic.

† More abundant and finer in Montane Macchia.

The following are usually epiphytic:—*Polypodium polypodioides*; *P. ensiforme*; *P. lineare*; *P. lanceolatum*; *P. lanceolatum* var. *sinuatum*; *Elaphoglossum conforme*; *E. petiolatum*.

*Gleichenia polypodioides* forms extensive consocieties, reaching many feet in height. *Osmunda regalis* (occasional, moist sites); *Todea barbara* (moist sites along river-banks); *Marattia fraxinea* (six to eight-feet fronds; mixed with *Hemitelia*).

The Lycopodiales are represented by the epiphytic *Lycopodium Gnidoides*, the small *L. Carolinianum*, and the prostrate, extensively developed *L. cernuum*.

## 2. Mosses.

There are numerous mosses, some of which have not as yet been described\*, but the more important ones, ecologically, are as follows:—*Ectropothecium regulare*; *Funaria hygrometrica*; *Hypopterygium laricinum*; *Papillaria africana*; *Plagiochila natalensis*; *Polytrichum commune*; *Polytrichum juniperinum*; *Porothamnium pennaeforme* (draping the crowns of trees in moist places); *Rhacopilum capense*; *Rhizogonum spiniforme*; *Syrrophodon pomiformis*; in addition, species of *Microthamnium*, *Campylopus*, *Macromitrium*, and *Fissidens*.

Apart from providing moisture-containing coverings to tree trunks and soils in many portions of the forests, the mosses do not appear to play an appreciable part in the forest-ecology. They certainly require more study than the writer has been able to give them.

## 3. Fungi.

The more important parasitic and saprophytic fungi occurring in the forests are the following:—

### (a) Parasitic Fungi.

Fungus.	Host.	Remarks.
<b>ASCOMYCETES.</b>		
<i>Perisporiaceae</i> —		
<i>Dimerium intermedium</i> ...	<i>Streptocarpus</i> Reckl .....	Causes loss of assimilative surface.
<i>Meliola amphitricha</i> .....	<i>Olea laurifolia</i> .....	Loss of assimilative surface, yellowing of leaves, often followed by death of part or whole of the infected leaf.
<i>Meliola conat</i> .....	<i>Pyrenacantha scandens</i> .....	Loss of assimilative surface, yellowing of leaves, often followed by death of part or whole of the infected leaf.
<i>M. Evansii</i> .....	<i>Elaeodendron croceum</i> .....	Loss of assimilative surface, yellowing of leaves, often followed by death of part or whole of the infected leaf.
<i>M. falcata</i> .....	<i>Plectronia ventosa</i> .....	Loss of assimilative surface, yellowing of leaves, often followed by death of part or whole of the infected leaf.
<i>M. gangliferæ</i> .....	<i>Curtisia faginea</i> .....	Loss of assimilative surface, yellowing of leaves, often followed by death of part or whole of the infected leaf especially in young seedlings.
<i>M. Hendelotti</i> .....	<i>Nuxia floribunda</i> .....	Loss of assimilative surface, yellowing of leaves, often followed by death of part or whole of the infected leaf especially in young seedlings.
<i>M. manca</i> .....	<i>Rubus</i> spp.....	Loss of leaves occasionally.
<i>M. Oleicola</i> .....	<i>Olea laurifolia</i> .....	Occasional loss of leaves; seedlings suffer most.
	<i>Olea capensis</i>	
	<i>Olea foveolata</i>	
<i>M. peltata</i> .....	<i>Podocarpus Thunbergii</i> .....	Leaves seldom die; seedlings seldom are infected.
<i>M. Rhois</i> .....	<i>Rhus</i> spp.....	Badly-infected leaves die slowly.
<i>Pileus africana</i> .....	<i>Olea capensis</i> .....	Slight loss of assimilative surface.
<i>Englerulaceae</i> —		
<i>Diathrypton radicans</i> .....	<i>Cunonia capensis</i> .....	Slight loss of assimilative surface; occasional death of portions of leaves.
<i>Parenglerula MacOwaniana</i>	<i>Elaeodendron Kraussianum</i> ...	Slight loss of assimilative surface; occasional death of portions of leaves.

\* Mosses: Specimens sent to Dr. T. R. Sim for identification.

(a) *Parasitic Fungi*—(continued).

Fungus.	Host.	Remarks
<i>ASCOMYCETES</i> —(Contd.).		
<i>Montagnellaceae</i> —		
Diplochorella amphinchena	Orysis abyssinica.....	Loss of leaves when severe.
<i>Polystomellaceae</i> —		
Hysterostoma capense....	Olea capensis.....	Loss of assimilative surface.
H. Faurae.....	Faurea McNaughtonii.....	Loss of assimilative surface.
Hysterostoma Eucleae.....	Euclea macroglossa.....	Loss of assimilative surface.
<i>Microthyriaceae</i> —		
Asterina celtidicola.....	Kiggelaria africana.....	Loss of assimilative surface; and occasional death of leaves.
A. delicata.....	Trinertia alnifolia.....	Loss of assimilative surface; and occasional death of leaves.
A. gerbericola.....	Gerbera piloselloides.....	Loss of assimilative surface; and occasional death of leaves.
A. Grewiae.....	Grewia occidentalis.....	Loss of assimilative surface; and occasional death of leaves.
A. reticulata.....	Olinia cymosa.....	Loss of assimilative surface; and occasional death of leaves.
A. rhamnocola.....	Rhamnus prinoides.....	Loss of assimilative surface; and occasional death of leaves.
Asterinella dissiliens.....	Elaeodendron croceum.....	Loss of assimilative surface.
A. Burchelliae.....	Burchellia capensis.....	Loss of assimilative surface.
Pteroclastria.....	Pteroclastrus variabilis.....	Loss of assimilative surface.
Capnodium spp. (many).....	All spp. of trees and shrubs.....	Loss of assimilative surface.
Engleriaster Gymnosporiae.....	Celastrus buxifolius (Gymnosporia buxifolia).....	Loss of assimilative surface.
E. orbicularis.....	Ilex (capensis) mites.....	Loss of assimilative surface.
Morenoella Phillipsii.....	Ocotea bullata seedlings.....	Loss of assimilative tissue, death of leaves, and drying of young stems.
<i>Dothideaceae</i> —		
Asterodothis solaris.....	Olea laurifolia.....	Loss of assimilative tissue, and death of leaves (vide J. F. Phillips, 1923).
<i>Coryneliaceae</i> —		
Corynelia fruticola.....	Myrsine melanophloeos fruits.....	Destroys germules.
C. liberata.....	Podocarpus Thunbergii podocarpa.....	Destroys embryo.
Tripospora tripos.....	Podocarpus elongata L'H. foliage.....	Does slight harm to the leaves, if very abundant.
<i>BASIDIOMYCETES.</i>		
<i>Uredineae</i> —		
Endophyllum (Macowaniana).....	Rhamnus prinoides.....	When severely attacked, the leaves become yellow.
<i>Pucciniaceae</i> —		
Aecidium Baumii.....	Plectronia Mundtii.....	Slight harm to the foliage.
A. Englercanum.....	Clematis brachiata.....	Slight harm to foliage.
A. oxalidis.....	Oxalis breviscapa.....	Slight harm to foliage.
Caeoma clematidis.....	Clematis brachiata.....	Hypertrophy of stem and leaves.
Phragmidium albidum.....	Rubus fruticosus.....	Often kills foliage.
Uromyces cyperi.....	Cyperus spp.....	Does slight harm.
<i>Thelophoraceae</i> —		
Stereum hirsutum.....	Olea laurifolia.....	On wounded trees; commences as a saprophyte, and attacks living tissue later.
Corticium vagum (Rhizoctonia solani)	Olea spp.; Apodytes dimidiata; Ocotea bullata seedlings.....	Produces a severe root-rot (vide J. F. Phillips, 1923).
<i>Polyporaceae</i> —		
Fomes applanatus.....	All species of trees, but particularly Olea laurifolia.....	Decay of, and ultimate death of trees.
F. geotropus.....	Ocotea bullata chiefly, but also on various other timber trees.*	Produces decay of tree.
F. hornodermis.....	Ocotea bullata.....	Produces decay of tree.
F. rimosus.....	Elaeodendron croceum and other trees.....	Produces decay of tree.
F. oroflavus.....	Curtisia faginea.....	Produces decay of tree.
F. Robinsoniae.....	Gonioma Kamassi.....	Produces decay of tree.
Fomes Yucatanensis.....	Curtisia faginea.....	Slight decay of tree.
Polyporus grammoccephalus	Nuxia floribunda.....	Very slight decay of tree.
P. sulphureus.....	Olea laurifolia.....	Slight decay; rare.
Trametes protea.....	Curtisia faginea.....	Slight decay.
Trametes glabrescens.....	Curtisia faginea.....	Very slight decay.
<i>Agaricaceae</i> —		
Schizophyllum commune..	Olinia cymosa and various other trees.....	Slight decay of tissue near wounds.

\* Podocarpus Thunbergii particularly.

Fungus.	Host.	Remarks.
<i>FUNGI IMPERFECTI.</i>		
Coniothyrium insigne.....	Ocotea bullata.....	Loss of leaf tissue.
Pestalozzia spp.....	(1) Flowers of Ocotea bullata...	Sp. nov., attacks the stigma, style, ovules. (J. F. Phillips, 1924) (f).
	(2) Fruits of Ocotea bullata...	Sp. nov., attacks the drupes, causing decay thereof. (J. F. Phillips 1924) (f).
Fusarium spp. (many)....	Various spp. of tree seedlings, but chiefly Podocarpus spp.	Death of seedlings.
	Very severe in nurseries	

(b) *Saprophytic Fungi.*

Fungus.	Remarks.
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*ASCOMYCETES.**Hypocreaceae—*

Nectria Peziza..... Assists in decomposing old wood.

*Xylariaceae—*

Daldinia concentrica..... Assists in decomposing old wood but very occasionally is parasitic

Halleria lucida stems.

Xnummularia lepidea..... Assists in decomposing old wood.

X. punctulatum..... Assists in decomposing old wood.

Xylaria apiculata..... Assists in decomposing old wood.

X. corniformis..... Assists in decomposing old wood.

X. hippoglossa..... Assists in decomposing old wood.

X. polymorpha..... Assists in decomposing old wood.

X. reticulata..... Assists in decomposing old wood.

X. Schweinitzii..... Assists in decomposing old wood.

X. tabacina..... Assists in decomposing old wood.

*BASIDIOMYCETES.**Tremellaceae—*

Exidia caespitosa..... Assists in decomposing old wood.

Tremella crassa..... Assists in decomposing old wood.

T. frondosa..... Assists in decomposing old wood.

T. fuciformis..... Assists in decomposing old wood.

T. lutescens..... Assists in decomposing old wood.

T. mesenterica..... Assists in decomposing old wood.

*Daeromycetaceae—*

Daeromyces deliquescent..... Assists in decomposing old wood.

D. digressus..... Assists in decomposing old wood.

Guepinia spatularia..... Assists in decomposing old wood.

*Thelephoraceae—*

Cladoderis spongiosa\*..... Assists in decomposing old wood.

Stereum fuscum..... Assists in decomposing old wood.

S. Kalchbrenneri..... Assists in decomposing old wood.

S. lobatum..... Assists in decomposing old wood.

*Clavariaceae—*

Clavaria cyanocephala..... Locally abundant, on sawdust.

*Hydnaceae—*

Hydnum sp. resembling H. erinaceum On decaying boles of Olea laurifolia.

Irpex fusco-violaceae..... Decays old wood.

I. vellerens..... Decays old wood.

*Polyporaceae—*

Daedalia stercoreoides..... Decays old wood, especially O. laurifolia.

Hexagona albida..... Decays old wood; not very common.

Laschia rubella..... Decays old wood; not very common.

Lenzites betulina..... Decays old wood; very common.

L. repanda..... Decays old wood; very common.

Polyporus australiensis..... Decays old wood.

P. cinnabarinus..... Decays old wood.

P. conchoides..... Decays old wood.

P. gilvus..... Decays old wood.

P. hirsutus..... Decays old wood.

P. lucidus..... Decays old wood.

P. ostreiformis..... Decays old wood.

P. sanguineus..... Decays old wood.

P. Telfairii..... Decays old wood.

P. velutinus..... Decays old wood.

P. versicolor..... Decays old wood.

P. zonatus..... Decays old wood.

Trametes hispida..... Decays old wood.

T. Hystrix..... Decays old wood.

T. obstinatus..... Decays old wood.

\* Frequent in moist forests only.

Fungus.	Remarks.
<i>Boletaceae</i> —	
<i>Boletus bovinus</i> .....	Frequent on humus soil.
<i>Agaricaceae</i> —	
<i>Agaricus campestris</i> .....	Frequent in Forests frequented by cattle and elephant.
<i>Lentinus Leonitei</i> .....	Frequent on old wood.
<i>L. Sajor-Caju</i> .....	Frequent on old wood.
<i>Leptota procer</i> .....	Frequent on soil rich in humus.
<i>Hymenogastraceae</i> —	
<i>Octaviania carnea</i> .....	Frequent on soil rich in humus.
<i>Sclerogaster africana</i> .....	Frequent on soil rich in humus.
<i>Lycoperdaceae</i> —	
<i>Battarea phalloides</i> .....	Frequent on soil rich in humus.
<i>Tulostoma cyclophorum</i> .....	Frequent on soil rich in humus.
<i>Arachnion album</i> .....	Frequent on soil rich in humus.
<i>Scleroderma cepa</i> .....	Frequent on soil rich in humus.
<i>S. tenerum</i> .....	Frequent on soil rich in humus.
<i>S. verrucosum</i> .....	Frequent on soil rich in humus.
<i>S. vulgare</i> .....	Frequent on soil rich in humus.
<i>Myceastrum corium</i> .....	Frequent on soil rich in humus.
<i>Bovistella aspera</i> .....	Frequent on soil rich in humus.
<i>Lycoperdon gemmatum</i> .....	Frequent on soil rich in humus.
<i>L. oblongisporum</i> .....	Frequent on soil rich in humus.
<i>Nidulariaceae</i> —	
<i>Cyathus Berkeleyanus</i> .....	Frequent on old wood, especially Podocarpus.
<i>C. microsporus</i> .....	Frequent on old wood, especially Podocarpus.
<i>C. Montagnei</i> .....	Frequent on old wood, especially Podocarpus.
<i>C. pallidus</i> .....	Frequent on old wood, especially Podocarpus.

The fungi play an important role in the life-history of the forest. The parasitic fungi have a directive influence in regeneration processes, the most important part in this connection being played by the Perisporiaceae and Microthyriaceae. Adult trees are often killed gradually by parasitic Polyporaceae.\* The saprophytic fungi, on the other hand, are directly useful in that they decompose wood, bark, and foliage, and thus enrich the soil.

A feature of the greatest significance is brought out when the tree and shrub and liane flora of the Knysna Forests is compared with the flora of the forests further east: there is a steady decrease in species as the west is approached. The Natal forests are richer floristically than those of the Transkei, the Transkeian are richer than the Kaffrarian, the Kaffrarian contain more species than do the Alexandrian, the Alexandrian show species that do not occur at Knysna. On the other hand, the Knysna forests are richer than the relict patches at Swellendam, and the latter contain more species than do the relicts in the Cape Peninsula kloofs. Marloth (1908: 200) draws attention to these facts, but the figures given by him—thirty-five of the fifty forest trees of the eastern forests occur at Knysna, twenty-six at Swellendam, and eighteen in the Cape Peninsula—require some modification now that better records of distribution are available.

An examination of the forest-floras of Natal, the Transkei, the eastern Cape Province, and of the Knysna region yields the following points of interest:—

1. *There are about 130 species of trees, woody shrubs, woody lianes, common to the forests of Natal, the Transkei, and the eastern Cape Province, that do not occur within the Knysna region.* These are as follows: *Popowia caffra*, *Capparis albitrunca*, *Niebuhria caffra*, *Cadaba natalensis*, *Dovyalis tristis*, *D. rotundifolia*, *Grewia flava*, *Cassinopsis tinifolia*, *Hibiscus tiliaceus*, *Dombeya Dregeana*, *D. cymosa*, *Erythroxylon monogynum*, *Toddalia† natalensis*, *Commiphora caryaefolia*, *C. Harveyi*, *Turraea obtusifolia*, *Trichilia emetica* (as far east as East London), *Ptaeroxylon utile*, *Allophyllus monophyllus*, *Sapindus oblongifolius*, *‡Zizyphus mucronata*, *Pleurostyli* *capensis*, *Gymnosporia cordata*,

\* Especially by *F. applanatus* and *F. geotropus*.

† *Toddalia natalensis* now is *Teclea natalensis* Eng.

‡ *Greyia Sutherlandi*.

*G. angularis*, *G. undata*, *G. albata*, *G. spp.* (three or four, uncertain), *Protorhus longifolia*, *Rhus spp.* (twenty-nine spp. occur in Natal, Transkei, and east, fifteen only at Knysna), *Harpephyllum caffrum* (*Odina caffra*), *Dalbergia armata*, *D. obovata*, *Erythrina humeana* (*E. caffra* just reaches the eastern limit of the Knysna region—Kromme River), *Calpurnia sylvatica*, *Schotia speciosa* (recorded from Knysna region, but not seen—doubtful), *Entada natalensis*, *Acacia caffra*, *A. hirtella*, *A. horrida* (just reaches eastern limit of Knysna region), *Leucosidea sericea*, *Choristylis rhamnoides*, *Homalium rufescens*, *Combretum salicifolium*, *Weihea madagascariensis*, *Eugenia cordata*, *E. Zeyheri*, *E. capensis*, *Gardenia globosa*, *G. neuberia*, *G. Thunbergia*, *Randia rudis*, *Pavetta lanceolata*, *P. obovata*, *P. caffra*, *Kraussia lanceolata*, *Electronia cilata*, *Vangueria infausta*, *V. macrocalyx*, *V. venosa*, *Brachylaena elliptica*, *B. discolor*, *B. racemosa*, *Maesa alnifolia*, *Chrysophyllum natalense*, *Mimusops obovata*, *M. caffra*, *M. marginata*, *Royena villosa*, *Maba natalensis*, *Euclea undulata*, *Olea Woodiana*, *Jasminum multipartitum* (*J. glaucum*, *J. angulare*, just touch the eastern limit of the Knysna region), *Strophanthus speciosus*, *Strychnos Henningsii*, *S. speciosa*, *Nuxia congesta*, *Chilianthus dysophyllus*,\* *Ehretia Hottentotica*, *Cordia caffra*, *Bowkeria simpliciflora*, *B. triphylla*, *Tecomaria capensis*, *Clerodendron glabrum*, *Vitex obovata*, *Xymalos monospora*, *Cryptocarya acuminata*, *C. Woodii*, *Peddiea africana*, *Dais cotinifolia*, *Osyridocarpus natalensis*, *Chaetachme aristata*, *Trema bracteolata*, *Ficus ingens*, *Croton rivularis*, *C. gratissimus*, *Cluytia Katherinae*, *C. natalensis*, *C. hirsuta*, *C. heterophylla*, *Euphorbia triangularis*, *E. tetragona*, *E. grandidens* (these tree Euphorbias just touch eastern limit of Knysna region), *Gelonium africanum*, *Acalypha peduncularis*, *Sapium Simii*, *Phyllanthus glaucophyllus*, *P. niaderaspalensis*, *Encephalartos Lehmanni*, *Encephalartos Altensteinii*, *E. longifolius*.

2. *There are about 130 species of trees, woody shrubs, woody lianes, common to the forests of Natal, the Transkei, the eastern Cape Province, and the Knysna region.* These are as follows: *Clematis brachiata*, *Knowltonia vesicatoria*, *Niebulria pedunculosa*, *N. triphylla*, *Capparis Guenzii*, *C. citrifolia*, *Scolopia Mundtii*, *S. Zeyheri*, *S. Ecklonii* (just reaches eastern limit of Knysna), *Kigelia africana*, *Dovyalis rhamnoides*, *Trimeria alnifolia*, *T. trinervis*, *Apodytes dimidiata*, *Cassinopsis capensis*, *Polygala myrtifolia*, *P. oppositifolia*, *Pittosporum viridiflorum*, *Abutilon Someratianum*, *A. indicum*, *Grewia occidentalis*, *Hlex capensis*, *Toddalia lanceolata*, *Clausena inaequalis*, *Calodendron capense*, *Ochna arborea*, *O. atropurpurea*, *Ekebergia capensis*, *Allophyllus erosus*, *A. decipiens*,† *Pappea capensis* (scrub forests)‡, *Scutia indica*, *Rhamnus prinoides*, *Noltea africana* (scrub forests), *Rhoicissus capensis*, *R. cirrhiflora*, *R. digitata*, *Cissus cirrhosa*, *Celastrus buxifolius*, *C. nemorosus*, *C. procumbens*, *C. polyacanthus*, *Celastrus acuminatus*, *C. peduncularis*, *Elaeodendron croceum*, *E. capense*, *E. Kraussianum* [and in coast forests, *Elaeodendron* (*Mystroxylen*) *aethiopicum*, *E. (M.) sphaerophyllum*], *Rhus laevigata* (*R. dentata*, *R. lucida*, *R. excisa*, *R. puberula*, *R. pyroides*, *R. obovata*, *R. crenata*, commoner in scrub), *Psoralea pinnata*, *Erythrina caffra* (just reaches eastern limit of the Knysna region), *Schotia latifolia* (rare tree in coastal forests, Knysna), *Cassia tomentosa*, *C. occidentalis*, *Pygeum africanum* (rare tree, Zitzikamma), *Cunonia capensis*, *Trichocladus crinitus*, *T. ellipticus* (rare shrub, Knysna), *Cussonia umbellifera* (local, Zitzikamma), *C. spicata* (just reaches scrub, eastern limit of Knysna region, and in the Longkloof), *Heteromorpha arborescens*, *Secamone Alpini*, *Curtisia faginea*, *Gardenia Rothmannia*, *Burchellia capensis*, *Psychotria*

\* In scrub on Eastern limit.

† *Hippobromus alata*.

‡ *Pappea capensis* in Eastern scrub.

capensis, *Plectronia ventosa*, *P. spinosa*, *P. obovata*, *P. Mundtii*, \**P. pauciflora*, *Osteospermum moniliferum*, *Tarchonanthus camphoratus*, *Senecio deltoideus* (eastern portion of Knysna region), *S. macroglossa* (eastern portion of Knysna region), *S. mikanioides*, *Mikania capensis*, *Myrsine africana*, *M. melanophleas*, *Sideroxylon inerme*, *Royena lucida*, *R. cordata*, *R. hirsuta*, *R. pallens*, *Euclea lanceolata*, *E. multiflora*, *E. macrophylla*, *Olea capensis*, *Olea laurifolia*, *O. foveolata*, *O. verrucosa*, *Azima tetracantha* (rare), *Carissa arduina*, *Acokanthera venenata*, *Nuxia floribunda*, *Chilianthus arboreus*, *Buddleia salviaefolia*, *Halleria lucida*, *Ocotea bullata*, *Osyris abyssinica*, *Celtis rhamnifolia*, *Ficus capensis*, *Ficus Burt-Davyi*, *Cluytia pulchella*, *C. affinis*, *C. laxa*, *C. Dregeana*, *Acalypha glabrata*, *A. Ecklonii*, *Andrachne ovalis*, *Salix capensis* var. *mucronata*, *Myrica conifera*, *Piper capense*, *Podocarpus Thunbergii*, *P. elongata*, *Widdringtonia cupressoides*, *Encephalartos caffer* (reaches the eastern limit of the Knysna region), *Strelitzia augusta*.

3. *There are about 20 to 25 species more or less peculiar to the Knysna region.* They are: *Sparmannia africana*, *Empleurum serrulatum*, *Dodonaea Thunbergianum*, *Hartogia capensis*, *Botryceras laurinum*, *Virgilia capensis*, *Platylophus trifoliatius* (extends to Swellendam), † *Cussonia thyrsoiflora*, *Myrica gilliana*, *Royena glabra*, *Euclea acutifolia*, *E. polyandra*, *E. racemosa*, *Olea exasperata*, *Gonioma Kamassi* (occurs sparingly as far as East London), ‡ *Freylinia undulata*, *Cluytia polifolia*, *C. pubescens*, *C. rubricaulis*, *Lachnostylis capensis*, *Myrica Burmannii*.

4. *There are about sixty species common to the Natal and Transkeian Forests that do not reach the Eastern Forests and those of the Knysna.* They are: *Niebuhrria Woodii*, *Capparis Woodii*, *Rinorea ardisaeiflora*, *Garcinia Gerrardi*, *Rawsonia lucida*, *Cola natalensis*, *Grewia lasiocarpa*, *Acridocarpus natalitius*, *Ochna Holstii*, *Allophyllus melanocarpus*, *Bersama lucens*, *Erythrina tomentosa*, *Milletia caffra*, *M. Sutherlandii*, *Albizzia fastigiata*, *Combretum erythrophyllum*, *C. Kraussi*, *Poirrea bracteosa*, *Rhizophora mucronata*, *Bruguiera gymnorhiza*, *Cassipourea verticillata*, *Eugenia Gerrardi*, *Oxyanthus Gerrardi*, *Alberta magna*, *Tarenna pavettoides*, *Plectronia Guenzii*, *Tricalysia capensis*, *Tarchonanthus trilobus*, *Maesa lanceolata*, *Carissa grandiflora*, *Rauwolfia natalensis*, *Conopharyngia ventricosa*, *Embelia ruminata*, *Buddleia pulchella*, *Anastrabe integrifera*, *Ruttya ovata*, *Mackaya bella*, *Adhatoda duvernoia*, *Vitex mooliiensis*, *Avicennia officinalis*, *Cryptocarya latifolia*, *Ficus craterostoma*, *Croton sylvaticus*, *Cluytia virgata*, *C. glabrescens*, *C. coedata*, *C. disceptata*, *Antedasma venosum*, *Macaranga capensis*, *Notobuxus natalensis*, *Acalypha petiolaris*, *A. punctata*, *A. Wilmsii*, *Sapium Mannianum*, *S. reticulatum*, *Spirostachys africana*, *Phyllanthus discoides*, *P. myrtaceus*, *P. Meyerianus*, *Drypetes arguata*, *D. Gerrardii*, *Olinia radiata*, *Cardiospermum halicacabum*.

5. *There are very few species occurring in the Transkeian and Eastern Cape Province Forests that do not occur in Natal.* These species do not occur at the Knysna. They are as follows: *Dovyalis caffra*, *Greyia Flanaganii*, *Ochna natalitia*, *Rhus mucronifolia*, *Rhus discolor*, *R. glaucescens*, *Pavetta Bowkeri*, *Royena lycioides*, *Euclea coriacea*.

6. *There are several interesting examples of discontinuous distribution:* *Cussonia umbellifera*, apart from its occurrence at Wit Els Bosch, Zitzikamma, is not known to grow west of the St. John's River; in the Zitzikamma it is confined to several forest patches in close proximity to each other. In these forests it is abundant and vigorous. *Faurea McNaughtonii* is known from

\* Recorded Flora Capensis III, 18, not collected.

† Since collected by General Smuts in mountains of Stellenbosch district.

‡ Since recorded from Nkandhla, Zululand.



several localities in the Transkei, and from one in Natal: it occurs in profusion in the Gouna Forest Reserve, Knysna, but is confined to one small forest; it is vigorous and fast-growing. *Pygeum africanum* is known from the Kaffrarian Forests, but does not occur in those in the Alexandria district; it occurs in one spot (about twenty trees only) at Blaauwkrantz, Zitzikamma. *Trichocladus ellipticus*, a common shrub of the eastern forests, occurs in several spots in the Knysna Forests, being represented by a few individuals only. *Psychotria capensis*, a common shrub of the eastern forests, is absent at Alexandria, and reappears in one spot in the Knysna region only—in the "Lilyvlei" Forest, Gouna.

From the foregoing it is seen that, of the 300 to 325 plants common to the forests of Natal and the Transkei (60 confined to Natal and the Transkei, plus 130 common to Natal, the Transkei, and the eastern forests, plus 130 common to Natal, Transkei, eastern forests, and the Knysna), about 250 to 255 only occur when the range is extended to the eastern Cape Province Forests—i.e., some 60 species drop out as the west is approached. It is further clear that, as the wide-ranging species at the Knysna number about 130 (excluding 25 that are practically endemics), approximately 180 to 185 species common to Natal and the Transkei drop out in the Knysna region—i.e., about 125 species in addition to the 60 or so which dropped out in the eastern Cape Province.

Bews (1925) rightly has pointed out the significance of this decrease, with respect to the origin and history of the subtropical species. He puts forward the highly suggestive hypothesis that the subtropical species of trees and shrubs are directly or indirectly derived from allied tropical forms in the great primitive forests of eastern and central Africa.

As Bews (1921) has suggested, from tropical species may be derived more temperate species, while these again, in their wanderings, on meeting new climatic, edaphic, or biotic conditions, may produce forms that are either more mesophytic or more xerophytic. The tree and shrub flora at the Knysna, as elsewhere in South Africa, is a derivative one, composed of subtropical species. Apart from considering these to have originated from tropical African forms, no feasible phylogenetic or geographic origin for these can be suggested. Climatic and topographic factors must have played, and must still be playing, considerable part in determining which species might proceed south and west, and how far such species might migrate in these directions. Owing to the barrier imposed by the great Kalahari, high veld, and Karroo regions to the north, and the extensive Namaqualand and Namib regions on the west, the invasion by the tropical-subtropical species could not have been directly south or southwest. The mountain barrier formed by the Drakensberg, Stormberg, Sneeuwberg, Nieuwveldt, and minor Cape ranges, and the coast-line itself, must have formed the indirect lines of invasion from the north and east.

Now, two factors may account for the comparative paucity of subtropical forms at the Knysna, at Swellendam, and in the Cape Peninsula. Firstly, the climate may have been unfavourable to those species requiring higher temperatures, experiencing different rainy seasons, and in some instances a lower annual rainfall: the poor acid soils, often in possession of macchia, may have proved uncongenial: still-undetected biotic factors may have assisted in precluding the establishment of others.

Secondly, we have to take into account those weighty factors, *distance and time*. Without subscribing to the Willis theory of "Age and Area" (Willis, 1922) to any more than a very slight degree, it seems evident that these factors may provide a part explanation of the poverty of the subtropical flora of the Knysna region. Assuming the source of the forms to have been in the Tropical Central and East African Forests, there can be little doubt that it must have taken the first-derived species considerably less time to reach the Transkeian

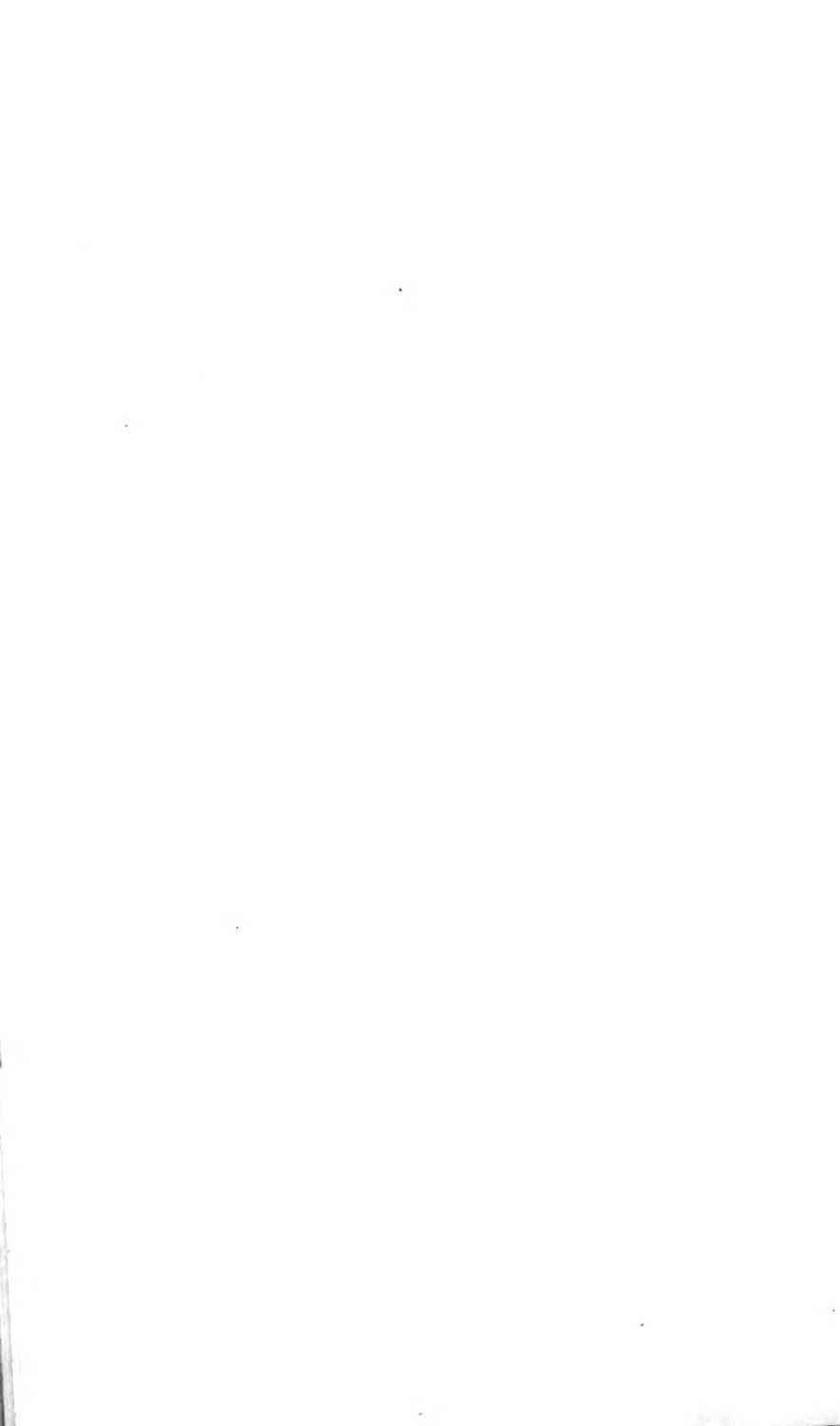
and Eastern Forests than it did to enter those of the Knysna, while they would have been in position in the latter region long ere they had made their appearance at Swellendam and the Cape Peninsula. For lack of the necessary perspective, we are unable to say whether or not in the ages to come species as yet limited to the Natal, Transkei, and Eastern Cape Province Forests may not appear in the Knysna. Migration along the mountain tops and slopes and along the coast-line must be taking place to-day as surely as was the case in Cretaceous and post-Cretaceous times.

It is felt that both hypotheses contain portions of the truth ; modifications probably have been brought about by other, and less important, agencies.

The occurrence of endemic forms at the Knysna does not, in the opinion of the writer, detract from the possibility of these suppositions containing in them portions of the truth, for the endemics may be looked upon as being derived from derivative subtropical species on the occasion of the latter experiencing some new set of conditions, climatic, edaphic, or biotic. Discontinuity in distribution is exhibited by the species listed under paragraph 6 above, and is accountable on the supposition of *polygenesis* having taken place : the same or an allied species forming in diverse localities the sources from which the new species originated.

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*Vide Appendix IV.*—Brief summary of Floristic data.



## Chapter VII.

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CONSTITUTION and STRUCTURE  
of the  
HIGH FORESTS.



## CHAPTER VII.

## CONSTITUTION AND STRUCTURE OF THE HIGH FORESTS.

## GENERAL.

The Knysna Forests, in common with most other South African Forests, are of a decidedly mixed nature. Unlike most European and North American, and certain Asiatic and Australian Forests, they show few pure communities so far as the dominant species are concerned—instead there is a general mixing of species. Occasional pure communities do, of course, occur, but these are of comparatively small extent. The most important species—*Olea laurifolia*, *Podocarpus Thunbergii* Hook., *P. elongata* L'Herit, *Ocotea bullata*, and *Apodytes dimidiata*—are large trees playing the parts of dominants and major subdominants throughout the greater portion of the Forests. *Olea laurifolia* and *Podocarpus Thunbergii* Hook.—as is seen from the frequency data given in Table XXXIII, p. 206—are the most abundant of the large trees. They are the most important of the dominants, and react more upon the factors of the habitat than do any of the other large trees covering the same area. *P. Thunbergii* Hook. when dense reacts strongly upon the soil moisture, the ground round the roots being often very dry to a depth of 18 inches, during periods of relative drought. *Olea laurifolia*, the most shallow-rooted tree in the Forests, too draws strongly upon the soil moisture but has a second and more important reaction—that of reducing to an appreciable extent, the light-intensity. Its crown is large, its foliage abundant, persisting over long periods, and of a dark olive green. There is little doubt that although other large trees rear their heads up to the level of the crowns of the two species under discussion, they are secondary in their reactions within the community. At all events their younger regeneration stages, in the climax communities, are to a large extent controlled by the two major dominants. The regeneration stages of these major dominants are able to tolerate excessive shade for very long periods without exhibiting inhibited growth or without dying, although they do, of course, grow faster and better when they are provided with better illumination.

*Olea laurifolia* and *Podocarpus Thunbergii* Hook. are usually more abundant on the warmer and drier aspects, and these are almost invariably the sites that carry luxuriant and extensive layer societies of *Trichocladus crinitus*, from 8 to 15 feet high. This layer society has been found to react both upon the soil moisture and upon the light-intensity—reducing both appreciably. The regeneration of species other than *Olea laurifolia* and *Podocarpus Thunbergii* Hook. that might readily flourish under cover of these major dominants, has to contend with this important layer society.

*Trichocladus* layers do occur in Forest where *Olea* and *Podocarpus Thunbergii* Hook. are not abundant, but are not usually so well developed in such localities.

There are two important biotic associates that tend to regulate the reactions of the two major dominants, and which probably prevent them from ultimately forming communities from which most or all of the other large tree species would be absent. The first of these is the fungus *Pomes applanatus* Gill, a wide-spread parasite of the boles of

*Olea laurifolia*, producing conditions of decay and ultimately death. Severely attacked trees, in addition, are frequently blown during strong winds. The second is the *Ascolichen Usnea barbata* Fries, the fungal component of which enters the outer tissues of the bark of the twigs and branches of *Podocarpus Thunbergii* Hook., and brings about gradual drying out and death of the crowns. Much of the foliage is enveloped in the waving "beard" of the organism, and thus is prevented from assimilating normally. *P. elongata* L'Herit, and *Apodytes dimidiata* occasionally show the evil influences of this organism [*vide* Phillips, 1929; for details of the ecology of *Usnea* and the supporting tree].

## THE PRINCIPAL SERAL AND CLIMAX COMMUNITIES IN HIGH FOREST.

### 1. *The Principal Priseral Communities.*

#### (a) *Consociés.*

The only consociés of any importance that are to be distinguished are described below. Most of these communities are of small extent, and mingle at the margins with one another, or with certain of the associates, consociations and associations described in this Chapter.

A *consociés* may be defined as a *seral community* characterized by a single dominant.

#### 1. *The Virgilia capensis consociés.*

This important community has been described by Phillips (1926:3) elsewhere. It is represented in hydroserral, lithoserral, and psammoseral successions, but most often develops in the first-named.

Development of the community takes place with *Macchia* as the origin, and from the community may develop several different associates in which *Virgilia* is one of the dominants.

*Virgilia* invades the *Macchia*, grows faster than the *Macchia* dominants, and within a year or two shades the latter to such an extent that gradual decrease in luxuriance is the result. The invader gradually increases in number and in size, and finally subjugates the few *Macchia* plants that remain on the ground.

The consociés is usually well-stocked—as many as 2,000-3,000 stems, 30 feet high and 6-18 inches girth at 4½ feet from the ground, are to be found per acre. The stems are usually upright and clean, and the crowns reduced but well balanced. The floor does not show the presence of regeneration of the dominant, but usually that of other Forest tree species, notably *Halleria lucida*, *Burchellia capensis*, *Plectronia Mundtii*, *Celastrus acuminatus*, and *Myrsine melanophleas*.

#### 2. *The Osteospermum moniliferum consociés.*

This consociés is best represented in coastal Forest and in some montane Forests. It is an early stage of the Forest sere proper, and develops to maturity within 5-10 years. The heavily-branched stems attain an average maximum height of 15-20 feet, and an average maximum girth of 6-9 inches. The canopy of the large shrubs form is well knit. The ground is usually clear of rank vegetation owing to the strong reaction upon the light. The consociés does not regenerate itself unless the older shrubs are removed and the soil is exposed to the sun. In time the community thins out owing to the death of some of its members, and seedlings of *Halleria*, *Burchellia*, *Royena*

*lucida*, *R. pallens*, *R. glabra*, *Celastrus buxifolius*, *Rhamnus prinoides*, *Plectronia* spp., establish themselves, finally developing to such a height that they convert the *Osteospermum* consocieties into a mixed associates of small trees and shrubs.

### 3. *The Sparmannia africana* consocieties.

The priseral *Sparmannia* consocieties is characteristic of the beds and sides of moist ravines near the upper limits of Forest lying on the mountain slopes, and of moist depressions within the Forests, not as yet held by taller growing communities. The consocieties grows to an average maximum height of 15 feet, the canopy formed being well knit, but allowing entrance to a large percentage of the light. The ground usually bears societies and societies of *Hydrocotyle asiatica* and spp., *Ranunculus pinnatus*, *Impatiens capensis*, *Plectranthus fruticosus* and *Cyperaceae*. Normally, regeneration of the dominant is sparse, despite the production of an abundance of seed; on being disturbed, the soil produces an abundance of tiny seedlings most of which succumb. The species coppices abundantly.

The consocieties is ultimately invaded by *Halleria lucida*, *Rhamnus*, *Polygala myrtifolia*, *Celastrus acuminatus*, *Royena lucida*, and *Plectronia* spp., the *Halleria* usually being the most abundant.

The consocieties is finally converted into the *Halleria—other spp. associates*.

### 4. *The Halleria lucida* consocieties.

This community, in its priseral state, is best represented in the moister Forests at higher elevations. It is seldom extensive in any one spot, but on the aggregate, covers a large area. The dominant attains an average maximum height of 15-25 feet, with boles of 12-24 inches at  $4\frac{1}{4}$  feet above ground. The tree is rarely upright, usually growing at angles. The canopy is well knit, but allows entry of a large proportion of light—from  $1/5$  to  $1/30$  of the total available exterior to the crowns. Occurring in the community as subdominants are *Rhamnus*, *Polygala myrtifolia*, *Celastrus acuminatus*, *Royena lucida*, the shrubby *Osteospermum moniliferum* and *Cluytia pulchella*. The usual procedure is for the consocieties to develop into either the *Halleria—and other spp. associates* or into a general mixed associates.

### 5. *The Brachylaena neriifolia* consocieties.

Consocieties of this species are widely spread along all water-courses, in the beds of ravines, in moist depressions, and along the moist S. and S.E. faces of the mountains at elevations below 3,500 feet. The large woody, shrubby dominant forms almost impenetrable communities; where it is well developed no other species are found in association with it, nor as subdominants within its borders. Along its margins, however, dense societies of *Todea barbara*, *Blechnum capense* and other ferns thrive. The reaction upon the light is very marked. On the death of members of the consocieties, invasion by *Sparmannia*, *Halleria*, *Osteospermum*, *Burchellia*, *Plectronia Mnudtii*, takes place, while the fern societies increase in size and in general luxuriance, the result being the development of the *Brachylaena neriifolia—other spp. associates*. *Brachylaena* does not regenerate itself in the consocieties.

### 6. *The Sideroxylon inerme* consocieties.

This is almost entirely confined to the Littoral Forests; a few examples, however, do occur in montane Forest of short nature.



The stout-stemmed, strongly branched, heavily foliated dominant attains in such communities an average maximum height of 25-30 feet, the girth at 4½ feet above ground being between 2 and 4 feet.

The boles, however, rarely stand upright, but are inclined at various angles. The canopy is dense, the reaction upon the light being strong. At the coast little ground vegetation occurs beyond occasional societies of *Knowltonia* spp., *Hypoestes aristata*, and *Aspidium capense*, and scattered plants of *Haemanthus puniceus*.

The species does not regenerate at this stage, although rich fruit crops are borne.

The consocieties must hold the ground for very lengthy periods, no change taking place, it is estimated, for at least a century, unless a number of the members be wind-blown.

#### 7. *The Ekebergia capensis consocieties.*

The *Ekebergia* consocieties is entirely coastal, usually occurring quite near the zone of Littoral Bush. There is no extensive development of this community, and those consocieties that do occur are small.

The general height of the community is from 25-35 feet, the boles ranging from 2 to 4 feet in girth at breast-height. The canopy is well knit, but allows entry to a good deal of light, more especially at seasons when the species is more or less deciduous.

Subdominants within the consocieties are *Plectronia ventosa*, *Celastrus buxifolius*, *C. acuminatus*, *Elaeodendron Kraussianum*, *Cassine scandens*, *Euclea macrophylla*, and other small trees and shrubs. *Knowltonia* spp., and *Hypoestes aristata* may form dense ground societies.

The dominant regenerates fairly well, provided the ground societies are not too dense.

A mixed associates appears to succeed the consocieties, which, however, seems to hold the ground for lengthy periods [*vide* Phillips, 1927: (4)].

#### 8. *The Myrsine melanophlecos consocieties.*

This community occurs throughout the Forest range, but shows its best development near the coast. While the individual communities are small, the total area covered by them is large.

The canopy is well formed, the average height being from 35-45 feet, the boles attaining girths at breast-height of 2-4 feet.

Subdominants are often numerous, being principally *Elaeodendron* spp., *Celastrus* spp., *Halleria lucida*, *Burchellia capensis*, and *Trichocladus*.

The dominant regenerates freely, but few of the millions of first-stage seedlings ever attain sapling size, owing to biotic enemies and to the strong reaction upon the light.

The consocieties may develop from the *Virgilia*—*Myrsine* associates the light-demanding *Virgilia* being ousted gradually by the shade-casting *Myrsine*. The consocieties seems to develop into a very mixed associates in which *Olinia cymosa* and *Pterocelastrus* are fairly abundant, or into the *Olinia*—*Myrsine* associates.

#### 9. *The Olinia cymosa consocieties.*

Biological features of interest have been described for the species by Phillips [1926: : (1)].

The community is well developed throughout the Forest range, but is particularly fine upon some of the drier ridges of the Uplands plateau.

The canopy is dense, the height of the consocieties ranging from 35-45 feet, the girths lying between 3 and 5 feet. The boles are well shaped and the crowns symmetrical.

Subdominants are *Pterocelastrus*, *Celastrus peduncularis*, *C. acuminatus*, *Elaeodendron croceum*, *Burchellia*, and sometimes *Myrsine* and *Ekebergia*. The ground societies are *Blechnum punctulatum*, *B. australe*, *Aspidium capense*, and *Schoenoxiphium lanceum*.

Regeneration is usually very rare, seed beds being far scattered.

The consocieties either develops into the *Olinia-Pterocelastrus* *associes* or into a more mixed community of various spp. none of which are definitely dominant. Occasionally development may be in the direction of the *Olinia-Myrsine* *associes*. The *Virgilia capensis consocieties* is often the origin of this community.

#### 10. *The Pterocelastrus variabilis consocieties.*

This distinctly variable species consisting of at least 3 well-marked forms, develops important consocieties throughout the Forest range. The best communities, however, are to be found on the drier ridges and on the warmer aspects of the Uplands plateaux. The stocking is dense, the canopy close, the reaction upon the light moderately strong. The average height is from 30-40 feet, the girths at breast-height ranging from 2 to 4 feet. The species exhibits plank buttresses, otherwise the boles are symmetrical.

Associated subdominants are *Olinia cymosa*, *Celastrus* spp., *Elaeodendron croceum*, *E. capense*, *Royena pallens*, *R. lucida*, *Lachnostylis capensis*, and *Plectronia obovata*. In course of time, these species, particularly the *Celastraceae* forms, increase in importance and convert the consocieties into the mixed *Celastraceae—other spp. associes*.

Frequent ground species are *Blechnum punctulatum*, *Moraea iridioides*, *Gerbera cordata*, and *Schoenoxiphium lanceum*.

#### 11. *The Podocarpus elongata L'Herit. consocieties.*

*The Podocarpus elongata consocieties*, the *Podocarpus consociation* (vide p. 180 this Chapter), and the *Podocarpus consocieties developing to form the Podocarpus elongata-other spp. association* (vide p. 181 this Chapter) are to be distinguished with care.

The *Podocarpus elongata consocieties* to-day is fairly well represented near the coast and along river valleys inland, only.

The consocieties originally consists of a fairly pure stand of young *P. elongata*; these in the course of four or five centuries attain maturity,\*<sup>1</sup> their dimensions being considerable: 120-140 feet full height, with boles 8-20 feet girth at breast-height. If the community be extensive and does not open up its canopy it remains climax—the *Podocarpus elongata consociation*. As a rule, however, the canopy is not sufficiently dense to preclude the establishment and growth of such spp. as *Podocarpus Thunbergii* Hook., *Olea laurifolia*, *Apodytes*, and *Ocotea*, and the consocieties is gradually converted into a climax community—a mixed association in which *P. elongata* is one of the major dominants. In other words, the term *Podocarpus consocieties* is

\*<sup>1</sup> Based upon their mean annual increment.

to be applied to a stand of the species either in its immature state, or in its mature state if its opened canopy encourages the establishment and growth of species such as those listed above.

*Such a consocieties developing to form an association* is well exemplified by the beautiful *Podocarpus elongata* Forest on the Groot River (*vide* Map), Knysna division. A brief description of this community follows:—

The *Podocarpus elongata* are hoary giants ranging from 5-23 feet in girth, and in full height from 80-120 feet, with huge, outspread limbs themselves many feet in length and several feet in girth. The boles and lower crowns are densely draped with tangles of *Senecio angulatus*, *S. mikanioides*, *S. quinquelobus*, *Mikania capensis*, *Scutia indica*, *Sarcostemma viminalis*, *Cynanchum obtusifolium*, *Secamone Alpini*, and species of *Cissampelos*, and *Zehneria*, and the dark green *Pyrenacantha scandens*. Not infrequently the parasitic *Ficus Burtt-Dayii* casts its strangling coils round the trees.

The epiphytic *Polypodium* spp., *Elaphoglossum conforme*, *Lycopodium gnidioides*, *Angraecum*, *Polystachya*, and *Mystacidium*, and *Peperomia relexa* are common upon the giant branches.

The number of boles of the dominant per acre varies from 1 to 10, the intervening areas bearing occasional *P. Thunbergii* Hook., *Olea laurifolia*, *O. capensis*, *O. foveolata*, *Apodytes*, *Ocotea*, *Calodendron*, *Toddalia*, *Kiggelaria*, *Celtis*, *Pterocelastrus*, *Elaeodendron*, *Kraussium*, *E. croceum*, *Sideroxylon*, of small size, and dense thickets of still smaller trees and shrubs, principally composed by *Olea capensis*, *Trimeria*, *Euclea macrophylla*, *E. racemosa*, *Royena pallens*, *Celastrus buxifolius*, *Cassine scandens*, and *Trichocladus*. The ground societies are of *Plectranthus*, *Hypoestes verticillata*, *H. aristata*, *Knowltonia glabriarcellata*, *Stelitzia augusta* occurs occasionally, sometimes over 30 feet in height.

The frequency of *P. elongata*, according to number of stems over 3 inches in girth at breast-height, is approximately 18% a high figure when it is remembered that very few young plants of the species occur.

## 12. *The Platylophus trifolius consocieties.*

This community has been described by Phillips [1925: (1): 147-148] elsewhere.

It is essentially a hydrosereal community arising during the occupation of the ground by the hygrophilous small tree and shrub stages (e.g. the *Brachylaena neriifolia*-other spp. *associes*.) It is best developed along moist valleys and in moist depressions on the plateaux, and in moist montane ravines. The communities are rarely extensive, usually being much longer than they are broad, their width seldom exceeding 50 yards. There are rarely more than 25 trees to the acre, as the boles (ranging from several to over 20 feet in girth at breast-height) lean at various angles, and as the crowns are much spread. The general height of the canopy is 40-50 feet. The reaction upon the light is excessive, and for this reason regeneration of seedling and sapling stages is sparse.

There are well developed *Hemitelia capensis* and *Marattia fraxinea* layers, while the boughs and boles bear rich epiphytic societies of Lichens, Mosses, *Lycopodium gnidioides*, *Polypodium*

ensiforme, *Polypodium lanceolatum*, *Elaphoglossum conforme*, *Hymenophyllaceae*, *Vittaria*, *Polystachya*, *Angraecum* and *Mystacidium*.

From all appearances, the consocieties remains on the ground many centuries, and in some instances seems to be of the nature of a subclimax community. In the normal succession the consocieties develops into the *Platylophus-Cunonia associes* through the invasion of opener, better illuminated portions by *Cunonia capensis*.

### 13. *The Cunonia capensis consocieties*.

In moist montane ravines and on the moist, cool slopes of the upper foothills this community is well represented. It rarely occurs on the plateaux, and is absent from the littoral.

The general height of the canopy varies from 10 feet to over 50 feet according to habitat, the controlling factors being holard, soil depth, and protection from wind. The stunted type generally is found on the more exposed, shallow-soiled portions of the higher altitudes, the better type on the secluded, deep-soiled sides of valleys.

The density of stocking is high, there being often as many as 50-70 boles (ranging from several feet to over 6 feet in girth at breast-height) to the acre, besides numerous saplings and poles. The younger stage regeneration is scanty (except for a few weeks after the fall of the millions of minute, winged, and delicate seeds) the reason for this poverty being the strong reaction of the trees and the associated *Hemitelia*, *Todea barbara*, *Marattia* and *Plectranthus fruticosus* layers upon the light. In addition, the soil is exceedingly moist, is cold and shows high acidity.

The communities on the more extreme, exposed sites seem to be of subclimax nature, but those on the better sites develop into mixed associations of moist type.

### 14. *The Tarchonanthus camphoratus consocieties*.

*Tarchonanthus camphoratus* forms small consocieties in Littoral Forest, and along the margins of drier type, isolated, inland Forest.

The boles are usually much inclined and the boughs are heavy and widespread. Below the dominant are fairly close layers of shrubs, the principal being *Euclea* spp., *Celastrus buxifolius*, *C. nemorosus*, *Rhamnus prinoides*, and *Carissa arduina*. The height of the dominant rarely exceeds 25 feet, while the girths range from 1½ to 2½ feet at breast-height.

The community ultimately develops into the *Elacodendron Kraussianum*-other spp. *associes* on the coast, and inland, into the *Celastraceae*-other spp. *associes*.

#### (b) *Associes*.

The *associes* of most general occurrence are described below. Like the consocieties these communities are seldom of any extent; they merge one into the other at times, and at others mingle on their margins with the consocieties already described.

An *associes* may be defined as a seral community characterized by two or more dominants.

### 1. *The Virgilia—Myrsine melanophlecos associes*.

This *associes* arises from the *Virgilia consocieties* in the event of there being present much larger numbers of seedlings and saplings

of *Myrsine* than of other Forest species (e.g. *Halleria*, *Burchellia*, *Plectronia Mundtii*, *Pterocelastrus*, *Olinia*.) The regeneration of *Myrsine* develops rapidly under the congenial light and moisture conditions available, and within 20-30 years is capable of sharing the dominance with *Virgilia*. The usual procedure is for the development of *Myrsine*—in size and in number—to proceed to such an extent that the *Virgilia* itself is ultimately dominated and ousted, the *Myrsine consociés* being the result.

The *Virgilia-Myrsine* *associes* attains an average maximum height of 30-45 feet, the boles ranging from 1-2½ feet in girth in the instance of *Virgilia*, and from 1½-4 feet in that of *Myrsine*.

Regeneration of *Myrsine* is abundant, and much of it develops until such time as the *Myrsine* itself reacts too strongly on the light.

## 2. The *Virgilia*—and—other species *associes*.

This mixed *associes* is the result of there being a fair representation of the seedlings and saplings of such Forest species as *Halleria*, *Burchellia*, *Plectronia Mundtii*, *P. obovata*, *Royena lucida*, *Celastrus* spp., *Pterocelastrus*, *Olinia*, *Olea capensis*, *O. foveolata* and *Nuxia floribunda*, present, and possibly a few plants of *Myrsine*, *Podocarpus* spp., *Ocotea*, *Apodytes*, and other of the larger and more valuable Forest trees.

The tendency is for the species listed to assume a co-dominance with *Virgilia*, and for them to subjugate and finally oust this plant. For a time, however, there is a fairly well balanced co-dominance, the usual co-dominants being *Virgilia*, *Halleria*, *Royena*, *Celastrus acuminatus* and *Pterocelastrus*. Regeneration of *Virgilia* does not appear,\* but that of the other species is usually abundant, while that of the larger tree species is also represented.

The community is an important one, ushering in as it does, the advance stages of the climax Forest.

## 3. The *Brachylaena neriifolia*—other species *associes*.

As already described (*vide* p. 171 this Chapter) this community develops from the *Brachylaena neriifolia consociés*. It may also arise direct from *Hygrophilous Macchia*. It is a very mixed *associes* consisting principally, it is true, of *B. neriifolia*, but showing in addition various partial co-dominants: *Halleria*, *Burchellia*, *Plectronia Mundtii*, *Osteospermum moniliferum*, *Rhamnus prinoides*, and *Sparmannia africana*. There is an abundance of *Todea barbara*, *Blechnum capense*, *Marattia fraxinea*, and in open sites, of *Pteridium aquilinum*. Saplings of *Platylophus trifolius* occasionally are to be found, for it is in this community that the *Platylophus* communities (*vide* pp. 192-193 and 198-199 this Chapter) have their origin. The canopy is rarely higher than 20-25 feet, and the stocking is dense in places but exceedingly sparse in others.

Despite the small size of the co-dominants, lianes and epiphytes are not uncommon, the general luxuriance of the vegetation being doubtless due to the high humidity of the habitat—which is usually in moist, cool valleys and depressions.

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\* Owing to the seeds (which are abundant) receiving no stimulus to germinate; the few plants that do appear are not able to develop owing to the low light intensity.

#### 4. *The Halleria—other species associates.*

*Halleria lucida*, *Burchellia*, *Royena lucida*, *Gonioma Kamassi*, are the usual co-dominants. Associated as subdominants are seedlings and saplings and poles of *Podocarpus Thunbergii* Hook., *Olea laurifolia*, *Apodytes*, *Ocotea*, and *Curtisia faginea*.

The associates is of wide occurrence, and of considerable importance. It is a frequent subseral community on the sites of exploitation and fire.

The canopy is well knit but not dense, excellent conditions of illumination being provided for the saplings and seedlings below. The average height is from 25-35 feet.

#### 5. *The Elaeodendron Kraussianum—other species associates.*

The community is developed in Littoral Forest and on drier, more coastal portions of the Uplands plateau. On the plateau, shallow-soiled ridges experiencing N. and N.W. aspects usually show the best communities.

*Elaeodendron Kraussianum* assumes an average maximum height of 25-30 feet and a girth of 2-2½ feet at breast-height. Its saffron-hued boles are rarely upright, but are generally inclined, and carry asymmetrically-placed crowns. Usually associated with this tree as co-dominants, are *Pterocelastrus variabilis*, *Ochna arborea*, *Sideroxylon inerme*, *Lachnostylis capensis*, *Royena lucida*, *R. pallens*, *Plectronia obovata*, *Plectronia ventosa*, and sometimes stunted *Podocarpus elongata* L'Herit. Subdominant species of importance are *Euclea macrophylla*, *Trichocladus*, *Celastrus buxifolius*, *Ochna atropurpurea* (shrub). The stocking is fairly dense, the canopy well knit, the reaction on the light strong. *Scutia* and *Secamone Alpini* are common lianes; ground communities are constituted by *Blechnum punctulatum*, *B. australe*, *Moraea iridioides*, *Tetraria* sp. nov.\*

Regeneration of *E. Kraussianum* is sparse, but that of *Pterocelastrus* and *Royena lucida* is more abundant, while that of *P. elongata* L'Herit may be locally abundant.

The origin of the community is identical with that of the *Celastraceae*-other species associates described below; it develops from the *Tarchonanthus consocius*. The associates appears to develop into the *Celastraceae*-other species associates which is of higher successional rank.

#### 6. *The Celastraceae—other species associates.*

This community principally originates through the increase in *Celastraceae* in an associates of the type above described: *Pterocelastrus* increases in number, while *Celastrus acuminatus*, *C. peduncularis*, *Elaeodendron croceum*, *E. capense* appear, and play important parts. *E. Kraussianum*, may, but generally does not, remain as a co-dominant or even as a sub-dominant.

Associated with the *Celastraceae* as co-dominants are some of the same species as occurred in the *Elaeodendron Kraussianum*-other species associates: *Plectronia obovata*, *Ochna arborea*, *Royena lucida*, *Olinia cymosa*, *Gonioma Kamassi* may occur fairly abundantly.

Species of lesser importance are *Lachnostylis*, *Royena pallens*, *Plectronia Mundtii*, *Burchellia*. The ground vegetation is much the same as in the *Elaeodendron Kraussianum*-other species associates.

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\* According to Dr. Schönland.

### 7. *The Pterocelastrus—Lachnostylis associates.*

Forests on Bokkeveld show the above community, more especially on drier ridges and on shallow-soiled slopes of N. aspect. In this community *Pterocelastrus variabilis* is a stunted tree of pole size only: 20-30 feet high with a girth ranging from 12-24 inches at breast-height. It occurs abundantly. The other dominant, *Lachnostylis capensis*, assumes fairly large dimensions when associated in this manner—short boles of 1½-2 feet girth are not uncommon, while the average maximum height is about 30 feet.

Mingled with the dominants are poorly-grown individuals of various species, especially *Olea capensis*, *O. foveolata*, *O. laurifolia*, *Plectronia obovata*, *Ochna arborea*, *Gonioma Kamassi*, while *Trichocladus crinitus* forms fairly dense layers. *Tetraria* sp. nov. and *Gerbera cordata* form the ground vegetation. Regeneration of all tree species mentioned is scanty.

The associates appears to remain subclimax for very long periods, but under favourable conditions (supplies of seed, opening up of the canopy of the consociates, increase in moisture content of the soil) develops into the *Celastraceae-other species associates* above described.

### 8. *The Olinia—Myrsine melanophloeos associates.*

In its purest form this community is not frequently met. It is to be found along certain Forest margins on the Uplands plateau.

The *Olinia cymosa consociates*, or the *Myrsine consociates* is its origin, and it appears to develop into the *Olinia-Pterocelastrus-other spp. associates*, in time.

The dominants have associated with them as subdominants such species as *Olea laurifolia*, *Podocarpus Thunbergii* Hook., and *Apodytes* in a stunted form. The general height of the dominants ranges from 30 to 40 feet, with the girths ranging from 3 to 5 feet.

### 9. *The Olinia—Pterocelastrus—other species associates.*

The *Olinia cymosa consociates* contains *Pterocelastrus* as a subdominant, and it in instances happens that this species is able to assume the importance of a dominant. There are associated with the dominants various subdominants: small trees of *Olea laurifolia*, *Podocarpus Thunbergii* Hook., *Apodytes*, *Ocotea*, *Curtisia*, and sometimes *Elaeodendron croceum* and medium-sized *Myrsine*.

The boles of the dominants are upright and the crowns symmetrical.

The average height is from 35-45 feet, the girths ranging from 2½-3 feet in the instance of *Pterocelastrus* and up to 5 feet in that of *Olinia*. The canopy is dense, the reaction upon the light strong. Regeneration of *Olea laurifolia* and *Podocarpus Thunbergii* Hook. is fairly well represented, that of *Olinia* being almost entirely absent, that of *Pterocelastrus* sparse.

On uncongenial sites the associates may remain in a subclimax state, but where the edaphic and biotic factors are favourable, the development is in the direction of mixed Forest of medium holard.

### 10. *The Platylophus—Cunonia associates.*

This community has been described by Phillips [1925 (1): 148-149] elsewhere. It develops from the *Platylophus consociates* (*vide* p. 174 this Chapter). In turn it is invaded by *Ilex mitis*, *Nuxia floribunda*, *Ocotea bullata*, *Apodytes*, *Podocarpus Thunbergii* Hook., and *Olea laurifolia*, which only assume dominance, converting the associates into a mixed climax association of moist type.

The average number of holes per acre in the associates is higher than in the *Platylophus consociet*, owing to the *Cunonia capensis* being more upright and less umbrageous than *Platylophus*.

The canopy is closed, but not as dense as that in the *Platylophus consociet*, as the crowns of the *Cunonia* are, on the whole, at a higher level than those of the *Platylophus*.

Regeneration of *Platylophus* is sparse, that of *Cunonia* more frequent. Seedlings of *Ilex*, *Apodytes*, *Ocotea*, *Podocarpus* spp., and *Olea laurifolia* occur. *Hemitelia*, *Blechnum capense*, and *Plecthanthus fruticosus* form close layers. The soil is moist, cold and acid but in lesser degrees than in the *Platylophus consociet*.

#### 11. *The Podocarpus elongata* L'Herit—other species associates.

This community is really a transition stage between the *Podocarpus elongata* L'Herit. *consociet* (vide p. 173 this Chapter), and the *Podocarpus elongata* L'Herit—other species association (vide p. 181 this Chapter). The account of the Groot River *Podocarpus elongata* L'Herit. Forest sufficiently describes the nature of this transitional stage.

#### 12. *The Cussonia umbellifera*—other species associates.

*Cussonia umbellifera*, apart from its occurrence in several Forests (Kwaaibrand, Koomansbosch) on the Witte Els Bosch Forest Reserve, is not found west of St. John's River mouth. In the Forests mentioned, there are abundant trees of the species, occurring in places in very small consociet, but more generally found in association with *Podocarpus Thunbergii* Hook. *Olea laurifolia*, *Apodytes*, and *Celastraceae*. Adult trees of *Cussonia* are from 40-50 feet in height, with girths ranging from 2½-5 feet. They are umbrageous.

The origin of the communities and their developmental nature are alike unknown, but it seems likely that they are of seral nature, hence their inclusion here.

#### 13. *Mixed associates.*

In addition to the twelve associates above described, there are various modifications of these, so numerous and so indistinctly separated, that it would serve no useful purpose to list and to describe them. The mixed associates, in common with those already described, are precursors of the mixed associations of the climax Forest.

*Subseral communities* are discussed in Chapter 10.

### (2) THE PRINCIPAL CLIMAX COMMUNITIES.

#### (a) *Consociations.*

*The consociation may be defined as a climax community characterized by a single dominant.*—This type of community is not well represented in the Forests of the Knysna, nor indeed in any other South African Forests. The sole moderately extensive consociation is that of *Podocarpus elongata* L'Herit. *Ocotea bullata* in montane ravines sometimes shows fragmentary consociations, while *Olea laurifolia* and *Podocarpus Thunbergii* Hook. very occasionally occur in very local pure communities. Indeed, one of the features that strikes the European botanist most forcibly in examining the Knysna Forests is the marked absence of pure dominance of any extent. The reason



for this absence is by no means clear; it is a general feature of tropical and sub-tropical woodland, and possibly is linked up with the phylogenetic history of the component species.

The few consociations requiring mention are described below.

### 1. *The Podocarpus elongata* L'Herit, consociation.

This community is a feature of the level ground within stream and river bows throughout the Forest range; it is also represented in ordinary climax Forest, but to a lesser extent. It is distinct from the *Podocarpus elongata* L'Herit consocieties (*vide* p. 173, this Chapter) in that it shows no tendency to change the pure dominance for a partial or mixed dominance. The giant trees rear their canopy 80-120 feet above the ground, this canopy being well knit and reacting fairly strongly upon the light. Layer societies of *Hemitelia* (moister sites) or of *Trichocladus crinitus* (drier sites) occur at the bases of the giant trees.

### 2. *The Olea laurifolia* consociation.

This community is always of local extent, and is always associated regionally with the *Podocarpus Thunbergii*—*Olea laurifolia*—other species association. Pure dominance of *Olea laurifolia*, however, does occur on small areas. The density of the heavily foliaged, extensively developed crowns is very great, the reaction upon the light being excessive. The trees are usually symmetrical, upright, and of full height 50-70 feet, their girths at breast-height being between 4 and 8 feet. Despite the weight of the crown and the size of the heavy bole, the roots are extremely shallow, the reaction upon the holard of the upper 6 to 18 inches of soil is therefore very great. Regeneration of the species occurs in great profusion a year or more after a fall of fruits (*vide Appendix I*, under the species), but fungus diseases account for the overwhelming majority of the young plants. The *Trichocladus crinitus* layer society is exceptionally well developed in this community.

### (b) Associations.

*The association may be defined as a climax community characterized by two or more dominants.*

Strange as the statement may seem, it is nevertheless true that this community is the best represented unit of vegetation in the Knysna Forests. At the same time, distinctly demarcated examples are by no means abundant, the reason for this being the innumerable variations in specific stocking shown by the climax Forests. One association merges with another, a third invades the margins of the second, and is itself to greater or less degree intermingled with the members of the tension zone of a fourth—and so on. *The climax Forest as seen to-day is in reality nothing but a synthesis or complex of a large number of associations*, except where seral communities exist and where local consociations and well-defined associations occur.

The degree of mixing of trees large and small in typical climax Forest is well set forth by the percentage frequency data shown in *Table XXXIII*, p. 183, and by the figures in *Tables XXXIV-V-VI* (pp. 184-186) for 2-acre portions of Forest on the Kaffirkop, Deepwalls, and Gouna Reserves.

The few associations that are fairly distinct are described below.

1. *The Podocarpus elongata L'Herit—other species association.*

This community consists of an upper story (80 to 130 feet high) of *Podocarpus elongata* L'Herit, the crowns of which in some instances almost touch, overlap in others, and are well separated in yet others. The second story usually is constituted by the taller individuals of *Podocarpus Thunbergii* Hook (70 to 90 feet high), the third story by numerous *Olea laurifolia* and by a scattering of *Ocotea*, *Apodytes*, *Myrsine*, *Ilex*, taller *Pterocelastrus*, and taller *Curtisia*; the fourth story is made up by *Nuxia*, *Elaeodendron croceum*, *Plectronia obovata*, and others; *Hemitelia* or *Trichocladus* form the layer societies.

The association has much in common with the *Podocarpus Thunbergii—Olea laurifolia—other species association* described below, the only difference of importance being that in the last-named association, *Podocarpus elongata* L'Herit, is either far less abundant or else is quite absent, and that large *Podocarpus Thunbergii* Hook. and *Olea laurifolia* are more numerous than they are in the association being described.

From a study of portions of undistributed climax Forest in various localities (e.g. at Deepwalls, Sourflats, Millwood, Gouna, Kaffirkop, Harkerville) it seems that the *Podocarpus elongata—other species association*—must have been more common before the exploitation of Forest commenced. *Podocarpus elongata* L'Herit. was exploited from the times of the first appearance of the European. In 1876 it was found that the larger individuals of this species, on account of their cumbersome nature, were being rejected by woodcutters, so in order to encourage the removal of such trees, 25 per cent. gratuity was granted on the licence-value of each such big tree. To this practice is due to some extent the paucity of *Podocarpus elongata* L'Herit. in some parts of the Forest, and its complete absence from others. At the same time it is evident that from large portions of Forest *Podocarpus elongata* L'Herit. has been absent many centuries, possibly through natural elimination in the development process.

As has already been described (*vide* pp. 173 and 174, this Chapter), the *Podocarpus elongata* L'Herit.—*other species association* develops from the *Podocarpus elongata* L'Herit. consocieties. It seems that in some instances, at all events, decay of the giant dominant results in the elimination of that species from the community, as a dominant, either for very many centuries, or for all time.

2. *The Podocarpus Thunbergii Hook.—Olea laurifolia—other species association.*

The above association is a decidedly mixed one, but shows as major dominants, *P. Thunbergii* Hook. and *Olea laurifolia*. The importance of the reactions of these species has been described already (*vide* p. 169, this Chapter).

Associated with the two dominants proper are large trees of *Apodytes*, *Ocotea*, *Ilex* (moist sites only), *Pterocelastrus*, smaller trees such as *Curtisia*, *Elaeodendron croceum*, *Celastrus* spp., *Plectronia obovata*, *Ochna arborea*, *Nuxia*, *Gonioma*, *Olea capensis*, *Lachnostylis*, *Halleria*, and *Kiggelaria*. *Podocarpus elongata* L'Herit. occurs sparingly if present at all. Dense layer societies of ferns and of *Trichocladus* occur.

The community constitutes the greater portion of the climax Forests. In it regeneration stages of *P. Thunbergii* Hook. are exceedingly well represented, those of *Olea laurifolia* scarcely as well. Seedlings, saplings and poles of *Apodytes*, *Ocotea*, *Pterocelastrus*, *Curtisia*, *Celastraceae*, occur in large numbers.

The rates of growth of the seedling, sapling and poles stages are low [*vide* Chapter 9, section (b)] owing to the very strong reaction of the large trees and shrubs upon the light, to the strong competition for soil moisture and solutes, and to the competition for growing space itself.

The percentage distribution transects described in this Chapter [*vide* Tables XXXIII–XXXVI (pp. 183–186)] to a great extent traversed communities of this type.

### 3. *The Faurea McNaughtonii*—other species association.

This association is represented in a single Forest at the Knysna only—that of “Lilyvlei,” Gouma Reserve. The *Faurea* has an interesting distribution (*vide* Chapter 6, p. 155), described elsewhere by J. F. Phillips [1927 (1)], and previously referred to by Kotze and E. P. Phillips (1919, 232–233, 235–238; and 1920, 221.).<sup>\*</sup>

In the “Lilyvlei” Forest *Faurea* occurs in portions as a dominant in the *Podocarpus Thunbergii*—*Olea laurifolia*—other species association, in other it is a mere sub-dominant within the same community.

The tree attains a height ranging from 50–70 feet, and girths running from 4 to 10 feet. The boles are upright, cylindrical, massive, the crowns well balanced. The foliage of young stage regeneration is entirely different in appearance from that of the adult tree: in the former the leaves are linear, in the latter broadly lanceolate.

Regeneration is plentiful despite the low fertility of the seed (*vide* Appendix 1, Table 5, therein). The rate of growth in all stages is moderately fast.

The origin of the interesting community is not known.

#### SPECIFIC CONSTITUTION OF THE TREE AND LARGE SHRUB LAYERS.

A very fair impression of the constitution of the tree and large woody shrub layers of the climax and semi-climax Forests of the Knysna is to be obtained from the data yielded by lengthy transects. Frequency transects several miles in length and from 22 to 44 yards in width, on which all tree species and the more important species of large woody shrubs above 1 inch diameter at breast height, were recorded, show the data set forth in *Table VXXVIII* (p. 183).

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<sup>\*</sup> Typed correction, June, 1920.

Table XXXIII.

PERCENTAGE FREQUENCY OF CHIEF SPECIES OF TREES AND SHRUBS (ALL INDIVIDUALS FROM 1 IN. DIAMETER AT 4½ FT.).

No.	Species.	Gouna. Fo. Fd.*	Deep- walls. FM. Fo.	Kafir- kop. Fo. Fo.	Harker- ville. Fo. FM.	Blaauw- krantz. Fo. Fd.	Lotter- ing. Fo. Fd.	Storms- River. Fo. FM.
1	<i>Podocarpus Thunbergii</i> , Hook.	9.82	8.76	11.51	9.31	6.43	6.09	5.70
2	<i>Podocarpus elongata</i> , L' Herit.	0.71	1.06	0.68	0.41	0.47	0.25	0.43
3	<i>Olea laurifolia</i> .....	17.77	10.31	19.48	11.27	9.74	10.33	8.05
4A	<i>Olea capensis</i> .....	5.60	7.18	5.21	10.77	4.81	5.20	5.28
4B	<i>Olea foecolata</i> .....	0.20	—	0.70	0.82	1.00	2.00	1.50
5	<i>Gonioma Kamassi</i> .....	17.54	4.70	10.93	10.29	9.36	10.48	7.62
6	<i>Apodytes dimidiata</i> .....	4.70	9.53	3.85	4.45	9.39	5.04	4.68
7	<i>Ocotea bullata</i> .....	3.16	2.51	1.36	2.19	2.65	2.19	5.18
8	<i>Curtisia faginea</i> .....	4.69	6.13	5.21	3.24	6.00	3.56	7.50
9	<i>Platylophus trifolius</i> .....	1.65	11.51	0.93	3.88	2.71	4.98	10.13
10	<i>Canonia capensis</i> .....	—	0.27	0.66	1.41	0.38	1.37	0.71
11	<i>Pterocelastrus variabilis</i> .....	4.41	0.98	6.51	8.68	11.15	19.56	8.50
12	<i>Elaeodendron crocunum</i> .....	2.94	4.43	4.46	4.10	4.70	3.87	2.28
13	<i>Celastrus acuminatus</i> .....	1.23	3.34	1.91	2.35	2.15	3.06	2.80
14	<i>Celastrus pedunculatus</i> .....	1.18	1.32	1.18	0.86	1.04	0.67	1.28
15	<i>Plectronia obovata</i> .....	3.00	1.90	4.05	2.90	2.66	1.87	1.78
16	<i>Plectronia Mundtii</i> .....	1.48	1.00	1.38	1.42	2.41	2.11	3.77
17	<i>Burchellia capensis</i> .....	7.63	5.22	5.39	3.17	5.88	5.22	9.03
18	<i>Faurca McNaughtonii</i> .....	1.18	—	—	—	—	—	—
19	<i>Olinia cymosa</i> .....	—	—	0.28	0.37	—	0.12	0.83
20	<i>Ochna arborea</i> .....	1.42	0.08	3.59	3.77	0.55	1.22	0.50
21	<i>Lachnostylis capensis</i> .....	0.30	0.81	3.21	0.76	0.32	1.00	0.30
22	<i>Myrsine melanophloeos</i> .....	0.68	—	0.14	2.72	0.25	1.90	1.18
23	<i>Ilex (capensis) mitis</i> .....	0.24	1.46	0.37	1.85	1.07	1.11	0.44
24	<i>Nuxia floribunda</i> .....	2.27	3.42	0.90	1.43	5.03	1.74	4.10
25	<i>Royena lucida</i> .....	3.11	4.52	3.72	2.66	2.76	1.37	2.33
26	<i>Halleria lucida</i> .....	1.73	9.56	2.63	1.49	6.65	1.49	3.78
27	Other species.....	1.30	—	0.36	3.43	0.41	2.20	0.29
		100.00	100.00	100.00	100.00	100.00	100.00	100.00

\* Forest types best represented.

Fd. — Dry type (holard = 25-35%).

Fo — Medium-moist type (holard = 45-60%).

FM. — Moist type (holard = 85-170%) [vide J. E. Phillips, 1928; (6).]

It is seen from these data that *Olea laurifolia*, *P. Thunbergii* Hook., *Gonioma Kamassi*, and *Pterocelastrus variabilis* are the most abundant species of trees. It is to be noted that the moist Forests are richer in *Platylophus trifolius* and poorer in *Olea laurifolia* than the dry.

The absolute density of the stocking in undisturbed Forest, so far as the trees and large woody shrubs are concerned, varies with the locality and with the ecological type. Thus the *Platylophus consocius* shows few stems to the acre, whereas the *Olinia cymosa consocius* shows a considerable number, but not as many as the *Pterocelastrus variabilis consocius* or the *Celastraceae*—other species associates. The following absolute density (or absolute frequency) data for several portions of Forest are of interest—all stems of trees and important woody shrubs, over 1 inch in diameter at breast-height being recorded:—

Name of Forest Reserve.	Nature of Forest.	Mean Absolute Density, i.e. Total Number of Stems (above 1 inch diameter) per Acre.
Deepwalls.....	Vide Table XXXVIII (p. 183) and maps of the Knysna region	471.5
Gouna.....	—	521.2
Harkerville.....	—	574.9
Kafirkop.....	—	630.6
Blaauwkrantz.....	—	441.1
Lottering.....	—	842.5
Storms River.....	—	694.5

The specific stocking for 2-acre portions of three different Forests—Kaffirkop, Deepwalls, and Gouna—is given in Tables XXXIV-V-VI:—

Table XXXIV.

## SPECIES AND NUMBERS OF TREES OCCURRING ON 2 ACRES OF FOREST, KAFFIRKOP, 1,000 FT.

Species.	Diameter Classes.																		Total.
	1-3	3-5	5-7	7-9	9-11	11-13	13-15	15-17	17-19	19-21	21-23	23-25	25-27	27-29	29-31	31-33	33-35	35-37	
<i>Olea laurifolia</i> .....	50	26	12	14	12	15	6	7	7	2	2	1	1	—	—	—	—	—	155
<i>Gonoloma Kanassi</i> .....	32	29	13	8	11	9	9	3	—	—	—	—	—	—	—	—	—	—	104
<i>Podocarpus Timberghii</i> , Hook.	30	16	5	9	—	—	—	—	—	1	—	1	—	—	—	—	—	—	94
<i>Burchellia capensis</i> .....	66	23	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	91
<i>Apodytes dimidiata</i> .....	39	19	4	1	2	3	1	—	—	—	—	—	—	—	—	—	—	—	69
<i>Curtisia tagina</i> .....	24	11	4	9	6	4	—	—	—	—	—	—	—	—	—	—	—	—	59
<i>Olea capensis</i> .....	16	24	3	8	3	1	—	1	1	—	—	—	—	—	—	—	—	—	57
<i>Royena lucida</i> .....	27	16	4	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	50
<i>Plectronia obovata</i> .....	21	6	2	4	3	2	3	2	2	—	—	—	—	—	—	—	—	—	45
<i>Ocotea arborea</i> .....	20	15	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	37
<i>Pterocelastrus variabilis</i> .....	9	4	4	6	4	4	3	2	—	—	—	—	—	—	—	—	—	—	36
<i>Elaeodendron croceum</i> .....	24	3	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	28
<i>Ocotea bullata</i> .....	11	2	1	2	2	1	—	2	—	—	—	—	—	—	—	—	—	—	24
<i>Lachnostylis capensis</i> .....	8	1	4	4	1	1	—	—	—	—	—	—	—	—	—	—	—	—	23
<i>Nuxia floribunda</i> .....	11	3	4	4	1	1	1	—	—	—	—	—	—	—	—	—	—	—	23
<i>Haliera lucida</i> .....	12	6	2	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	21
<i>Royena pallens</i> .....	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>Gardenia Rothmannia</i> .....	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>Olea foveolata</i> .....	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>Kiggelaria africana</i> .....	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>Fagara pavyi</i> .....	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>Plectronia Mundtii</i> .....	—	5	4	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	15
<i>Celastrus acuminatus</i> .....	—	1	4	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	7
<i>Celastrus pedunculatus</i> .....	—	2	1	1	—	1	—	—	—	—	—	—	—	—	—	—	—	—	5
<i>Podocarpus elongata</i> , L'Herit.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3
<i>Ilex (capensis) multiflora</i> .....	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	451	219	74	74	48	41	23	18	10	3	2	2	3	—	—	—	—	1	969

Table XXV.

SPECIES AND NUMBERS OF TREES OCCURRING ON 2 ACRES OF FOREST, DEEPWALLS, 1,400 FT.

Species.	Diameter Classes.																	Total.							
	3	5	7	9	11	13	15	17	19	21	23	25	27	29	31	33	35		37	39	41	43	45	47	49
<i>Halleria lucida</i> .....	82	41	21	13	6	4	3	2	2	4	5	—	—	—	1	—	1	—	—	—	—	—	—	—	167
<i>Platylophus trifoliatus</i> .....	42	31	24	17	8	6	6	2	1	—	—	—	—	2	1	—	—	—	—	1	1	—	—	—	151
<i>Apodytes dimidiata</i> .....	39	23	20	3	6	3	2	1	1	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	100
<i>Curtisia rugosa</i> .....	23	7	13	8	4	3	2	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	63
<i>Olea capensis</i> .....	26	19	13	1	1	1	1	4	4	4	—	3	1	1	—	—	—	—	—	—	—	—	1	—	60
<i>Olea laurifolia</i> .....	6	14	10	5	3	3	2	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	58
<i>Nuxia floribunda</i> .....	14	17	10	6	3	3	2	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	57
<i>Burchellia capensis</i> .....	44	11	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	55
<i>Royena lucida</i> .....	28	15	4	3	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	53
<i>Orotea bullata</i> .....	5	5	1	1	3	3	—	2	1	1	1	1	—	—	1	—	1	—	—	1	1	—	—	—	51
<i>Celastrus psittacularis</i> .....	6	9	3	3	3	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	50
<i>Podocarpus Thunbergii</i> , Hook.....	3	7	1	2	2	2	2	1	1	1	1	—	—	2	—	—	1	—	—	—	—	—	—	—	52
<i>Plectronia Mundtii</i> .....	7	1	3	4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	24
<i>Elaeodendron croceum</i> .....	9	3	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	15
<i>Celastrus acuminatus</i> .....	5	2	4	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	13
<i>Ilex (capensis) nifis</i> .....	4	4	3	—	—	1	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	10
<i>Gonoloma Khamassi</i> .....	7	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	9
<i>Olea foveolata</i> .....	—	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>Kigelia africana</i> .....	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>Fagara Dayl.</i> .....	6	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	8
<i>Gardenia Rothmannia</i> .....	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>Podocarpus elongata</i> , L. Herl.....	2	2	1	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	8
<i>Plectronia obovata</i> .....	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3
<i>Pterocelastrus variabilis</i> .....	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2
	358	210	134	68	41	31	12	13	11	10	8	4	1	5	2	—	3	—	—	2	1	—	1	—	915







The table gives a *general impression of the change with aspect*, but must not be considered as showing the average percentage distribution according to aspect, for the whole of the Forests of the Knysna, for conditions of community as well as edaphic and climatic factors of the particular habitat, have to be taken into account site by site.

#### MINOR COMMUNITIES.

In addition to the upper layers composed by large trees and large woody shrubs, there are several minor communities that deserve brief description.

##### (a) *Lower Layer Societies.*

The number of important lower layer societies is small, the best developed being the following:—

- (1) *The Trichocladus crinitus layer societies* frequent in Forests on dry and medium-moist soils; this society is always under canopy.
- (2) *The Hemiteelia capensis layer societies* frequent in Forests of moist nature; this society is always under canopy.
- (3) *The Blechnum capense layer societies* frequent in Forests of medium-moist and moist nature; this society is always under canopy.
- (4) *Todca barbara and Marattia fraxinea layer societies* in moist Forest; these societies are usually under canopy.
- (5) *Piper capense layer societies* frequent in medium-moist and moist Forest—always under canopy.
- (6) *The Plectranthus fruticosus layer societies* characteristic of moist Forest, and less luxuriant in medium-moist Forest; always under canopy, except in portions of Forest exploited or burnt.
- (7) *Mixed layer societies* (composed of such species as *Rhamnus prinoides*, *Polygala myrtifolia*, *Cluytia pulchella*, *Carissa arduina*, *Celastrus nemorosus*, *Euclea macrophylla* (smaller, *Royena glabra*), occur in portions of Forest where layers (1), (2), and (6) above are not well represented. Such layer societies occur under canopy.
- (8) *The layers of open portions of the Forest* are described in Chapter 10.

The layer societies (1) and (2) above are referred to in several places in this paper, but a brief account of their influence in the life-history of the Forest organism is not out of place at this stage.

Experimental work at Deepwalls is showing that these two layer societies are among the most potent biotic conditions controlling the natural regeneration of Forest trees. Briefly the position is as follows:—

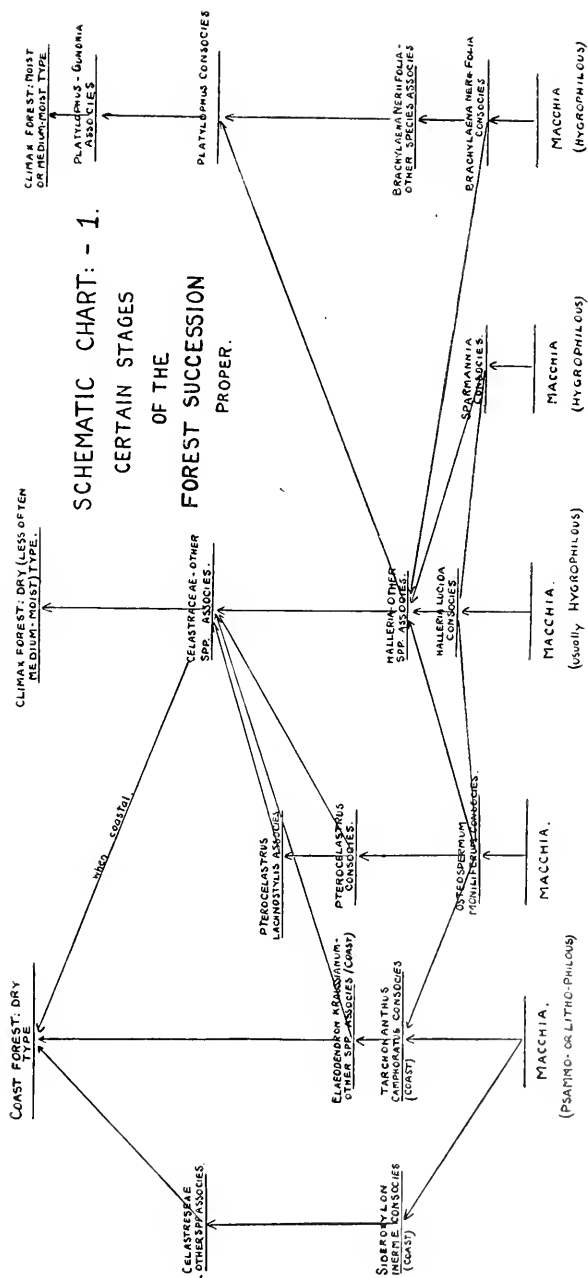
*Trichocladus crinitus* forms societies that cut down the light-intensity at, and several feet above ground-level, as low as 1/200 to 1/500, on the brightest days. In addition these societies reduce the soil-moisture in the upper 6 to 12 inches of soil, to such an extent that delicate seedlings are either unable to establish themselves on emerging from seeds, or else do so with great difficulty and grow extremely slowly. Elimination of the *Trichocladus* layers as pointed

## CERTAIN STAGES

OF THE

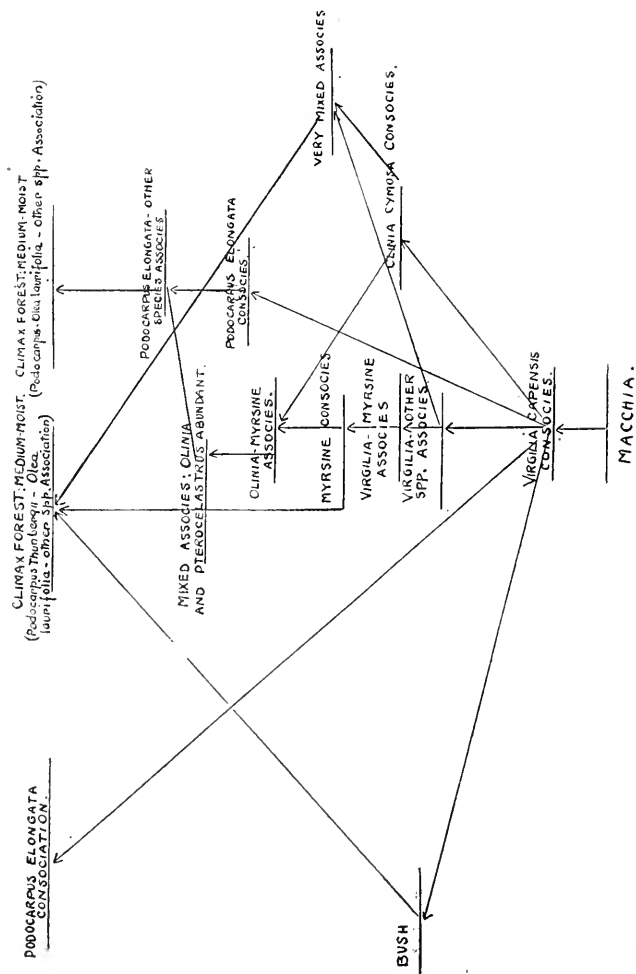
## FOREST SUCCESSION

PROPER.



# SCHEMATIC CHART II CERTAIN STAGES OF THE FOREST SUCCESSION PROPER

XXVI.



out in Appendix 3, produces beneficial results, so far as appearance and growth of tree regeneration is concerned, within several months. Increased light supply (the value at ground-level rises to 1/30-1/60 on removal of the *Trichocladus*) and decreased competition for the moisture of the upper 12 inches of soil, appear to be the direct causes of this improvement.

*Hemitelia capensis*, so far as the light-intensity is concerned, acts in the same manner as *Trichocladus*, only the values at ground-level and immediately above, are reduced much further—ranging from 1/500 to 1/1200 on bright days. The dense cover of fern reduces evaporation from the soil; little wind disturbs the almost stagnant air; the relative humidity is usually within a few per cent. of saturation; the temperature of air and of soil is low. In addition the ferns shed a copious supply of litter and build upon an acid humus (pH 4.8-pH 4.4); the increased humus produces a soil heavily charged with water. (120 per cent. to 200 per cent. on the dry-weight of ovened samples.) Fungous diseases are often severe under cover of the ferns, and such seedlings as do manage to establish themselves despite the uncongenial light, humidity, and edaphic conditions, are frequently destroyed by these diseases. Elimination of the ferns produces beneficial results in germination and establishment of Forest forms, within the course of a year.

#### (b) Ground Vegetation.

The flora of the Forest floor is not particularly rich in species. Seedlings of the various Forest trees and large woody shrubs are well represented on the whole. Important plants are the following:—

*Knowltonia glabricarpellata*, *K. rigida*, and *K. vesicatoria*, forming societies in drier Forest, particularly near the coast and on warm ridges inland.

*Aspidium capense*, *Blechnum punctulatum*, *B. australe*, forming societies in drier Forest; *Pteridium aquilinum* forming dense societies on opener sites in both moist and medium-moist Forest; *Lycopodium cernuum* forming prostrate societies on opener sites, moist or dry.

*Hypoestes verticillata*, *H. aristata*, *Gerbera cordata*, *G. piloselloides*, *Ficinia sylvatica*, *Moraea iridioides*, and *Aristea pusilla* are commonly found on dry and medium-moist Forest floors, while *Impatiens capensis*, *Scirpus tenellus*, *Mariscus congestus*, *Ficinia capillifolia*, *Juncus capensis* var. *flaccidus*, *Scirpus prolifer*, *Juncus lomtophyllus*, *Hydrocotyle asiatica*, and *Ranunculus pinnatus* frequent moist positions. *Zantedeschia aethiopica* forms extensive societies in opener, moist sites.

The following examples of analyses of ground vegetation according to the method of Raunkiär (*vide* Smith, W. G. 1913, 22-26 for an account of Raunkiär's methods) employing analysis-circles of 1 sq. metre, are instructive. It is seen that the exploited Forest shows a larger proportion of herbaceous forms than does the natural Forest.

Natural Forest at Harkerville. Species occurring (no plants over 10 feet in height recorded).	Number of 1-sq. metre circles on which they occurred out of a possible 100.
Plectronia Mundtii seedlings.....	80
Trichocladus crinitus seedlings.....	68
Myrsine melanophlecos seedlings.....	68
Moracae iridioides (geophyte).....	56
Celastrus acuminatus seedlings.....	48
Apodytes dimidiata seedlings.....	46
Zehneria obtusiloba (liane).....	42
Royena lucida seedlings.....	38
Secamone Alpini (liane).....	36
Burchellia capensis seedlings.....	34
Blechnum punctulatum.....	34
Polystichum pungens.....	34
Elaeodendron croceum seedlings.....	32
Plectranthus fruticosus.....	30
Carex aethiopica.....	30
Podocarpus Thunbergii Hook seedlings.....	28
Oxalis sp. (no flowers).....	26
Asparagus sp. (no flowers).....	24
Aspidium capense.....	22
Blechnum capense.....	22
Olea laurifolia seedlings.....	20
Galopina circaeoides.....	20
Scutia Commersonii (S. indica) (liane-form).....	18
Cluytia pulchella.....	16
Pterocelastrus variabilis seedlings.....	14
Gonioma Kamassi seedlings.....	14
Celastrus buxifolius seedlings.....	14
Hemitelia capensis.....	12
Pyrenacantha scandens (liane).....	12
Trimeria alnifolia seedlings.....	10
Ochna arborea seedlings.....	8
Rhoicissus capensis.....	8
Ocotea bullata seedlings.....	8
Impatiens capensis.....	8
Ilex mitis seedlings.....	6
Aristea pusilla (geophyte).....	6
Rubus pinnatus.....	4
Kiggelaria africana seedlings.....	3
Celastrus peduncularis seedlings.....	3
Elaphoglossum conforme (on ground).....	3
Curtisia faginea seedlings.....	2
Gerbera cordata.....	2
Ekebergia capensis seedlings.....	2
Carissa arduua.....	2
Exploited Forest adjacent to above.	
Plectranthus fruticosus.....	80
Blechnum punctulatum.....	50
Cluytia pulchella.....	44
Plectronia Mundtii seedlings.....	42
Trichocladus crinitus seedlings.....	40
Aspidium capense.....	40
Moracae iridioides (geophyte).....	38
Halleria lucida seedlings.....	38
Polystichum pungens.....	37
Galopina circaeoides.....	32
Burchellia capensis seedlings.....	32
Ilex mitis seedlings.....	27
Helichrysum petiolatum.....	26
Carex aethiopica.....	24
Olea laurifolia seedlings.....	24
Myrsine melanophlecos seedlings.....	24
Apodytes dimidiata seedlings.....	23
Royena lucida seedlings.....	22
Oxalis sp. (no flowers).....	21
Osteospermum moniliferum.....	20
Asparagus sp. (no flowers).....	18
Clematis brachiata (liane).....	17
Cluytia affinis.....	14
Rubus pinnatus.....	14
Pyrenacantha scandens.....	15
Helichrysum diffusum.....	14
Podocarpus Thunbergii Hook seedlings.....	14
Impatiens capensis.....	13
Ocotea bullata seedlings.....	12
Nuxia floribunda seedlings.....	12
Ochna arborea seedlings.....	10
Kiggelaria africana seedlings.....	10

Exploited Forest adjacent to above ( <i>continued</i> ). Species occurring (no plants over 10 feet in height recorded).	Number of 1-sq. metre circles on which they occurred out of a possible 100.
<i>Physalis pubescens</i> (P. <i>peruviana</i> ) (exotic).....	9
<i>Blechum capense</i> .....	8
<i>Curtisia faginea</i> seedlings.....	8
<i>Aristea pusilla</i> (geophyte).....	8
<i>Platylophus trifolatus</i> seedlings.....	6
<i>Senecio quinquelobus</i> (liane).....	6
<i>Zehneria scabra</i> (liane).....	6
<i>Wahlenbergia procumbens</i> .....	6
<i>Secamone Alpini</i> (liane).....	6
<i>Rhamnus prinoides</i> seedlings.....	6
<i>Hemitelia capensis</i> .....	6
<i>Rubus fruticosus</i> (exotic).....	6
<i>Piper capense</i> .....	4
<i>Pteridium aquilinum</i> .....	4
<i>Celastrus peduncularis</i> seedlings.....	4
<i>Celastrus buxifolius</i> seedlings.....	4
<i>Elaeodendron croceum</i> seedlings.....	4
<i>Trimeria aluifolia</i> seedlings.....	3
<i>Gerbera cordata</i> .....	3
<i>Dolichos gibbosus</i> (liane).....	3
<i>Carissa arduina</i> .....	3
<i>Helichrysum foetidum</i> .....	3
<i>Cissus cuncifolia</i> .....	2
<i>Olea capensis</i> seedlings.....	2
<i>Celastrus acuminatus</i> seedlings.....	2
<i>Sonchus oleraceus</i> (exotic).....	2
<i>Hydrocotyle asiatica</i> .....	2
<i>Solanum nigrum</i> .....	1
<i>Pterocelastrus variabilis</i> seedling.....	1
<i>Passiflora quadrangularis</i> (liane) (exotic).....	1

(c) *Lianes*.

Contrasted with the subtropical Forests of Natal and Zululand and with those of the Transkei and Kaffraria, the Knysna Forests are remarkably poor in all lianoid growths; the poverty is still more pronounced when the lianoid flora of the tropical African Forests is contrasted with that of the Knysna.

As the woody liane is probably the most primitive form of liane, it is rather surprising that the Knysna Forests should show so few species. It is difficult to understand why *Popowia*, *Dalbergia*, *Strophanthus*, *Behnia*, which are in the Eastern Forests, do not appear at Knysna; they have not (except *Behnia*) even reached the Alexandrian Forests about 50 miles East of Port Elizabeth.

While the woody form is probably relatively primitive among lianes, it is interesting to note that the Knysna species, except *Clematis* and *Capparis citrifolia*, belong to comparatively high developed families. The non-woody twiners, except *Cissampelos* and *Antizoma capensis* (Menispermaceae), too, belong to families fairly high in the phylogenetic scale. There are no endemic lianes, all the species occurring, being wide ranging Eastward and some of them proceeding even Westward.

If the lianes are few in species they are certainly very abundant in numbers of individuals, most portions of the Forests being festooned with *Clematis*, *Asclepiadaceous* lianes, *Rhoicissus capensis*, and others rendered impassable by *Scutia*, *Capparis*, and *Rubus pinnatus*. The undergrowth is usually bound by tangles of *Zehneria* and *Pyrenacantha*. The total damage done to saplings and poles by lianes is probably quite considerable, numerous malformed stems being found on every acre.

For the sake of ready reference the principal lianes are listed below:—

#### WOODY LIANES.

- Clematis brachiata* \* (Ranunculaceae): stem from 1 to 3 inches diameter.  
*Capparis citrifolia* (Capparidaceae): armed.  
*Scutia Commersonii* (S. indica) (Sapindaceae): armed, kills many trees; at times takes shrub form.  
*Rubus pinnatus* (Rosaceae): armed.  
*R. rigidus*: armed, commoner in coastal Forest.  
*R. fruticosus*: this armed exotic at times takes liane form, ascending many feet and doing much harm to young trees.  
*Grewia occidentalis* (Tiliaceae): scandent shrub, commoner near coast.  
*Secamone Alpini* (Asclepiadaceae): stems from 1 to 3 inches diameter, does much harm to trees; much sought by elephant.  
*Ficus capensis* (Moraceae): occasionally assumes lianoid form; does much damage to trees.  
*F. Burtt-Davyi*: does much damage.  
*Rhoicissus capensis* (Vitaceae): very abundant in opener Forest and near the coast; forms dense cover over trees; does much harm.  
*R. digitata* is frequent on the coast and in opener inland Forest.  
*Cissus cuneifolia* occurs principally in coastal Forest.  
*Senecio angulatus*: frequent in coastal Forest.  
*S. mikanioides*: frequent in coastal Forest.  
*S. quinquelobus*: frequent in coastal Forest.  
*S. deltoideus*: occurs toward the Eastern limit of the region.  
*Mikania capensis*: frequent in all Forests.  
*Vernonia anisochaetoides*: abundant in open Forest.  
†*Asparagus* spp. (Liliaceae): twiners best developed in dry Forest.

#### NON-WOODY OR ONLY SLIGHTLY WOODY LIANES.

- Antizoma capensis* (Menispermaceae): occasional.  
*Cissampelos torulosa* (Menispermaceae): frequent.  
*Pagelia bituminosa* (Leguminosae): frequent on coast only.  
*Dolichos gibbosus* (Leguminosae): frequent in open Forest.  
*Astephanus neglectus* (Asclepiadaceae): frequent.  
*A. marginatus* (Asclepiadaceae): frequent.  
*Cynanchum obtusifolium* (Asclepiadaceae): frequent.  
*Tylophora syringaeifolia* (Asclepiadaceae): frequent.  
*Tylophora* sp. (Asclepiadaceae): frequent.  
*Sarcostemma viminalis* (Asclepiadaceae): frequent on coasts; succulent and leafless.  
*Zehneria* (Meloethria) *obtusiloba* (Cucurbitaceae): very abundant.  
*Zehneria* (Meloethria) *hederacea* (Cucurbitaceae): very abundant.  
*Zehneria* (Meloethria) *punctata* (*Z. scabra*) (Cucurbitaceae): very abundant.  
*Pyrenacantha scandens*: very abundant.

#### MISCELLANEOUS CLIMBERS.

- Pollinia nuda* (Gramineae).  
*Gleichenia polypodioides* (Gleicheniaceae).

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\* *C. brachiata* Thunb. including *C. Thunbergii* Steud, which cannot be distinguished satisfactorily.  
† *Cussonia thursiflora* is sometimes lianoid, trailing long distances up rocks and ascending trees.

#### (d) Epiphytes.

At the Knysna epiphytes are abundant as to numbers of individuals but poor as to numbers of species. Bews (1925: 95) in discussing woodland epiphytes in South Africa generalizes that epiphytes are few in species and not abundant individually. So far as the writer is able to state from his own observations, the Pirie, Amatola, and Alexandrian Forests of the Eastern Cape Province certainly are poor in numbers of epiphytes. The Knysna Forests, however, are much richer in numbers of individuals—in moister portions almost every tree shows epiphytic societies poor in numbers of species rich in numbers of individuals.

The epiphytic habit is probably a derivative one, infinitely better represented specifically in the tropical African Forests.

The epiphytic flora within the Knysna Forests is as follows:—

Cryptogamic epiphytes.	Remarks.
<i>Usnea barbata</i> Fries.....	This Ascolichen ( <i>Discolichenes</i> . . . thallus heteromorous) is widespread, particularly on <i>Podocarpus</i> spp. and <i>Apodytes</i> crowns. The fungal component often acts semi-parasitically on the outer bark of the supporting tree.*
<i>Porothamnium pennaeforme</i> .....	This moss drapes the lower layers in moist portions of the Forests.
<i>Lycopodium gnidioides</i> .....	Particularly on <i>Ocotea bullata</i> .
<i>Polypodium ensiforme</i> .....	
<i>P. lanceolatum</i> .....	Often terrestrial (old wood).
<i>P. lanceolatum</i> var. <i>sinuatum</i> .....	" "
<i>P. lineare</i> .....	" "
<i>Elaphoglossum conforme</i> .....	" "
<i>E. petiolatum</i> .....	" "
<i>Asplenium gemmiferum</i> .....	" "
<i>A. biphinnatum</i> .....	" "
<i>Vittaria isoetifolia</i> .....	Particularly on <i>Ocotea bullata</i> .
Orchidaceous epiphytes.	Remarks.
<i>Polystachya Ottoniana</i> .....	Sometimes terrestrial (old wood).
<i>Angraecum bicaudatum</i> .....	Rarely terrestrial (on old wood).
<i>A. Burchellii</i> .....	" "
<i>A. conchiferum</i> .....	" "
<i>A. pusillum</i> .....	" "
<i>A. sacciferum</i> .....	" "
<i>Mystacidium filiforme</i> .....	" "
<i>Calanthe natalensis</i> .....	Frequently terrestrial (on old wood).
<i>Listrostachys arcuata</i> .....	Rarely terrestrial.
Dicotyledonous epiphytes.	Remarks.
<i>Streptocarpus Rexii</i> .....	Particularly on boles of <i>Ocotea</i> .
<i>Peperomia reflexa</i> .....	Often on old wood on ground.
<i>P. retusa</i> .....	Often on old wood on ground (more local).
<i>Ficus capensis</i> and <i>F. Burt-Davyi</i> .....	These species are very variable in their form; they may commence life as epiphytes and later become parasites, and still later, self-dependent trees or scandent shrubs.

\* *Vide* Phillips, 1929.

The epiphytes in the Knysna Forest, on the whole, do not show very marked preferences for particular species of trees, except that *Ocotea* is preferred by *Streptocarpus* and *Lycopodium gnidioides*.

This subject of preference for particular supporting plants, however requires to be studied along the same lines as those adopted by L. J. Pessin (1925: 17-37.) in his thorough investigation of *Polypodium polypodioides* and its preferences.

S., S.E., and S.W. sides of trees are preferred at the Knysna, owing to their being slightly cooler and moister.

A point of interest is the occurrence of *Peperomia reflexa* and *Peperomia retusa* and *Calanthe natalensis* as terrestrial plants, this occurrence possibly reflecting their phylogenetic history.

#### (c) *Phanerogamic parasites.*

The Forests of the Knysna are remarkably free from phanerogamic parasites, the only species occurring on trees or large shrubs being *Viscum obscurum*,\* *Cassytha ciliolata*; *Uncuta* sp. nov. of Schönland, *S. appendiculata*, and *C. africana* (all on *Virgilina capensis* but doing little damage); the variable-formed *Ficus capensis* and *F. Burt-Davyi* at times act as parasites.

\* *Viscum obscurum*: On *Olea laurifolia* and *Platylophus trifoliatus*, the crowns of which suffer to some extent.



*Fungous saprophytes and parasites are listed in Chapter VI.*

### FOREST TYPES.\*

The significance of the term "*Forest type*" has been much debated by American foresters within recent years. (*vide* Clements 1920: 337-344 for a concise account of the various views put forward.)

Briefly, the term as used by some foresters, is equivalent to "*site*" or "*locality*," but by the majority it is understood to refer to the "*cover*" or "*vegetation*"; unfortunately certain writers have employed the term in describing *successional stages*. In the present communication the term implies *forest of climar or semi-climar nature characterized by the mean moisture-content (holard) of the soil and by the resultant changes reflected in the vegetation both dominant and subdominant*. In a word, Mason's (1913: 91) and Greeley's (1913: 76) "physical" and "cover" types are both included in the meaning.

The Forest types defined within the Knysna region are:—†

- (1) *The Forest of Dry Type.*
- (2) *The Forest of Medium-moist Type.*
- (3) *The Forest of Moist Type.*

Habitat modifications of the above types are as follows:—

- (1) *Forest of Coastal Type* (shorter form of Types 1, 2, and 3 above).
- (2) *Forest of Montane Type* (shorter form of Type 3 above).

As is implied by their names, the physical explanation of the separation of these types resides in different mean holard values, these differences being reflected either in the floristic composition (particularly in the lower layer and ground societies), or in the growth quality of the forest cover.

The five types above listed are described in tabular form:—The Types 1, 2, and 3 of the first series, are indicated on the vegetation maps of the region.

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\* For a fuller account of the *Forest types* in the Knysna region and a discussion of the criteria employed, *vide* Phillips, 1928: (6). The cognate subject of *Plant Indicators* for the Knysna region is dealt with in Phillips, 1928: (5).

† December, 1930: F. S. Laughton, my successor at Deepwalls, has reclassified the types; for sake of obviating confusion in nomenclature I give Mr. Laughton's terms along with my own:—

*Dry Type* (J.P.) = *Dry Type* (F.S.L.)

*Medium-moist Type* (J.P.) = *Medium-moist* (F.S.L.) and *Moist Type* (F.S.L.) in part.

*Moist Type* (J.P.) = *Moist Type* (F.S.L.) in part.  
= *Wet Type* (F.S.L.).

Type.	Mean Holland at 18 inches (dry- weight).	General Nature of the Soil.	Aspect Favoured.	General Position.	Floristic Features.				Nature of the Growth in the Upper Layers.
					Upper Layers.		Lower Layers.		
DRY*	25-35 %	Humus dry, its pH 5.5-7.3. Sandy-loam 18- 24 inches deep, over Clay or broken rock, or pan of lateritic nodules. (Usually a shal- low soil; water often runs off humus surface as on a graded surface. Dry type Forest is well repre- sented on soil overlying Bok- keveld beds.	N., N.W., W., but rarely S., S.E., and E.	Within several miles of the coast; along steep river gorges; on ridges of the plateaux; occasionally on shallow- sloped ridges of foothills.	Absent Typically.	Present Typically.	Absent Typically.	Present Typically.	
					Hydrophilous spp., chiefly Platylophus, Cunonia, Ilx; Ocotea may be present spar- ingly but is poorly grown.	All other tree spp., but no- tably Plectronia obovata, Lachnostylis, Pterocelastrus, Elaeocandron croceum, Olinia, Myrsine, Gonioma often abundant.	<i>Under Canopy</i> , Hemitelia capensis, Blechnum capense, luxuriant B. punctatum, Todea barbara, Marattia fraxinea, Piper capense, Cyper- aceae, except Ficinia leiocarpa and Schoenoxiphium lanceum. Epiphytic Polypodium and Elaphoglossum spp., the draping Moss, Pterothamnium, pennaeformis.  <i>Open Sites</i> , Sparmannia africana, Brachylaena nerifolia.	Dense societies of Trichocladius crinitus, bound together with such small lianes as Pyrenacaulis scandens, Cyano- clum, Melothria, Antizoma, and Thorny shrubs (e.g. Carissa, Doryalis and Celastrus homocarpus and C. buxifolius) are abundant. Cassipoupa capensis is less frequently found. On the ground are Gerbeira spp., Moraea iridoides, small Blechnum punctatum, B. australe. Common are Hypoestes verticillata, Knownltonia spp., and Ficinia leiocarpa. Aspidium capense is locally abundant.	The mature and semi-mature domi- nant trees are of lesser height and diameter than in the <i>Medium</i> and <i>Moist</i> types. The mean height of the top of the canopy ranges from 40 to 50 feet. Podocarpus elongata is rarely greater than 90-100 feet. Boles are often twisted in grain and much fissured; the wood is harder than in the other types, especially on the N. and N.W. sides of the trees and on the N. and N.W. as- pects. Crowns are often stag-headed and the twigs dry; Usnea barbata decks the exposed crowns of Podocarpus spp. and of Apodytes. REGENERATION AB- SENT OR SPARSE; Podocarpus spp. seedlings may be locally frequent.

\* *Vide* Phillips, 1928; (6): 191-194.

Table XXXIX.

Type	Mean Holland at 18 inches (dry- weight).	General Nature of the Soil.	Aspect Favoured.	General Position.	Floristic Features.				Nature of the Growth in the Upper Layers.		
					Upper Layers.		Absent Typically.	Present Typically.		Lower Layers.	Present Typically.
					Absent Typically.	Present Typically.					
MEDIUM- MOIST.†	45-60 %	Humus medium moist, its pH 4.8-5.5. Sandy-loam or Clay-loam over Clay. Lateritic pan of nodules may be pre- sent, but is usually not thick. Usually a moderately deep to deep soil; not heavy and not cold. Medium type forest is found on some of the better class soils overlying Bokkeveld beds. It is found on soils over Pre- Cape beds and Granite; it is chiefly over steep-dipping T.M.S.	Any aspect.	From within a few miles of the sea to the foothills; not often on the lower mountain slopes. Not on ridges nor in moist nor dry valleys.	Platylophus, Cinnola— scattered far- individuals near locally moisture sites. Olinia is rare except along the forest margins and in seral forest of medium-moist type. Pterocladus and Elaeodendron croceum much less fre- quent than in the Dry type. Elaeodendron Kraussianum never appears. Ilex may be scattered through the type but is not large.	All spp. may occur but the dominants are Podocarpus Thunbergii and Olea laurifolia; P. elongata may be locally dominant.	Hemitelia capen- sis, Marattia fraxinea, Todaea barbata, in any abundance or luxuriance. Impatiens capensis. Hydrocotyle asiatica, Cyperus tenuellus, Fuchsia capilli- folia, Scirpus prolixa, Juncus lomatophyllus, J. capensis, are found in locally moist places only. Knottia spp., Euclea macro- phylla, Cassia scandens, Rovena pallens, Ficinia leocarpa, except on small locally drier sites.	Blechnum capense, B. punctulatum. Aspidium capense (luxuri- ant in nature) abundant. Trichocladus erectus abundant and of taller and stronger growth than in the Dry type. Plectranthus fruticosus abundant but not as tall and dense as in the Moist type. Epiphytic Polypodium and Euphorbia multiflora abun- dant and less luxuriant than in the Moist type. Hymeno- phyllaceae locally frequent only.	Variable, but on the whole infinitely bet- ter than in the Dry type. The best parts bear compari- son with the best parts of the Moist type so far as Podocarpus is concerned. Platylophus is poorly grown. Excellent Podocar- pus spp., Olea laurifolia and Apodytes occur; Gonioma is abun- dant, its growth better than in the Dry type. Timber of better quality than in the Dry type; the Stinkwood (Orotea) not as good as in Moist Forest. REGENERATION EXCELLENT IN PARTS, IN OTHERS SPARSE. Seedlings of Podocar- pus Thunbergii Olea laurifolia Apodytes dimidiata Celastraceae abundant in places.		

## NOTE TO TABULAR STATEMENT.

In general, the *Medium-moist* type is distinct from the *Dry* type in virtue of its taller, finer, better-crowned dominant, and sub-dominant trees, in virtue of its better regeneration of all stages, and on account of its deeper, moister, slightly more acid soil. The ground vegetation is more luxuriant than in the *Dry* type. It is distinct from the *Moist* type in that it contains no (or very few) hygrophilous dominants and but few fern societies, Hemitelia layers being notably absent; its regeneration stages are better than in the *Moist* type, and the soil on which it grows is much less heavy, is less acid, and on the whole of better nature, than that of the *Moist* type. • Vide Phillips, 1928; (6): 194-196.

Table XL.

Type.	Mean Holland at 18 inches (dry- weight).	General Nature of the Soil.	Aspect Favoured.	General Position.	Floristic Features.				Nature of the Growth in the Upper Layers.
					Upper Layers.	Present Typically.	Absent Typically.	Lower Layers.	
Moist.	85-170 %	Humus exceedingly moist, its pH 4.0-4.8. Sandy-loam over a Clay-loam over Clay; or Clay-loam over Clay. Drainage usually poor. Cold and heavy. <i>Moist type</i> rarely on soil overlying Precambrian or Granite; very rarely on that of Bokkeveld beds.	S., S.E., and S.W.	Along river beds; in moist bluffs, both on the plateau and along the mountain sides.	Absent Typically.	Present Typically.	Absent Typically.	Lower Layers.	Nature of the Growth in the Upper Layers.
					Large individuals of other tree spp., especially of Podocarpus elongata, Olca laurifolia, Elaeodendron croceum, Proteoclastrus, Plectroelia obovata. Notably absent are Olma and Lachnocythys.	Platylophus, Cunonia, are abundant. Ilex mitis is locally frequent; Ocotlea is scattered or locally frequent. in some sites Apodytes dimidiata and Olca laurifolia are found scattered. Some sites hold Cunonia and Platylophus only, others, these spp. and a scattering of many other spp. found in type. Gomboa is rare.	Trichocladus erinitus layers of any extent or of any luxuriance. Cassine scandens, Euclea macrophylla, and most of the thorny shrubs of Dry forest. Knowltonia, hyphae, Ficinia lolocarpa, Aspidium capense.	Dense societies of Hemitelia capensis, Blechnum capense, luxuriantly by Ocotlea and Cunonia, while some fine Ilex is sometimes found; the crowns are well developed and the boles are symmetrical; in other sites the growth is short and the crowns and boles asymmetrical. Platylophus communities usually show strongly asymmetrical boles and crowns. Some of the finest Protea (Stinkwood) thicket comes from Moist forest in the mountains. REGENERATION IS ABSENT OR VERY SPARSE except where the ferns have been destroyed or where the upper canopy is lighter.	Variable; in sites excellent height and diameter growth are shown, especially by Ocotlea and Cunonia, while some fine Ilex is sometimes found; the crowns are well developed and the boles are symmetrical; in other sites the growth is short and the crowns and boles asymmetrical. Platylophus communities usually show strongly asymmetrical boles and crowns. Some of the finest Protea (Stinkwood) thicket comes from Moist forest in the mountains. REGENERATION IS ABSENT OR VERY SPARSE except where the ferns have been destroyed or where the upper canopy is lighter.

Table XII.

Type.	Mean Hoard at 18 Inches (dry- weight).	General Nature of the Soil.	Aspect Favoured.	General Position.	Floristic Features.				Nature of the Growth in the Upper Layers.
					Upper Layers.		Lower Layers.		
					Absent Typically.	Present Typically.	Absent Typically.	Present Typically.	
COAST.	Varies with the Moisture type, the <i>Dry</i> , <i>Medium</i> , and <i>Moist</i> types being present. In places 25-35% in others 35-60%	Varies with topography but Sandy-loam is the best represented; its depth except on ridges and ravine sides is considerable. The pH values naturally vary with the Moisture type, but in general the higher pH values apply.	Any, but generally S., S.W., S.E.	Within 1-3 miles of the sea, or on well sheltered, deeper-soiled sites, within a few hundred yards of the sea.	Varies with the Moisture type: the <i>Dry</i> and <i>Medium</i> types being much better represented than the <i>Moist</i> , the latter being confined to moist kloofs.	Varies with the Moisture type. Myrsine, Olinia, Elaeodendron, Kraussanum, are not uncommon. <i>Elephantorrhiza</i> , <i>Sideroxylon</i> , <i>Calodendron</i> are found, sometimes in fair numbers, <i>Pittosporum viridiflorum</i> and <i>Sceloparia</i> spp. are local.	Varies with the Moisture type. Best represented are the Lower layers of the <i>Dry</i> types and <i>Medium</i> types. In addition the following are common:— <i>Haemanthus pumilus</i> , and <i>Hypoestes aristata</i> , and on open sites, the large shrub <i>Ostocarpum moniliferum</i> is abundant and well grown.	On sites exposed to the sea wind the height-growth is much shorter and the diameter-growth much less than inland, type for type. The crowns are usually asymmetrical owing to the influences of the winds, and they are much draped in <i>Usnea barbata</i> . On less exposed sites there is a general increase in height and diameter, type for type, but in general the dimensions are below those holding further inland. The timber is good except on the more exposed sites.	

NOTE TO TABULAR STATEMENT.

*Coast* type Forest is distinguished by its close proximity to the sea and the shorter height growth of the tree species, Moisture type for Moisture type, but portions of the *Moist* type in well-protected positions differ but little in height growth as compared with the same type inland; the *Dry* and *Medium* types differ to a much greater degree.

\* Vide Phillips, 1928; (6): 198-199.

Table XLIII.

Type	Mean Holland at 18 inches (dry- weight).	General Nature of the Soil.	Aspect Favoured.	General Position.	Floristic Features.				Nature of the Growth in the Upper Layers.
					Upper Layers.		Lower Layers.		
					Absent Typically.	Present Typically.	Absent Typically.	Present Typically.	
MONTANE. •	85-170 % as for the <i>Moist</i> type. In places up to 190 %	Usually heavy Clay-loam over rock. Humus abundant, and acid. PH 3.9-4.8.	S., S.W., S.E., rarely N., and N.W.	Deep secluded kloods in the mountains, from 2,500- 4,500 feet.	Most of the species of the mixed forests of the plateaux and foothills; notably <i>Podocarpus</i> <i>elongata</i> , <i>Olinia</i> , <i>Plectronia</i> <i>obovata</i> , <i>Pterocelastrus</i> , <i>Myrtille</i> ( <i>Apodytes</i> ) in places may be frequent.)	Platylophus, Cunonia, are the most abundant, forming pure and mixed communities. In sites <i>Oreoclea</i> occurs, along with <i>Hex-</i> Large <i>Virgilia</i> sedges at lower elevations; in this species is much stunted at the higher.	Trichocladius and other shrubby layers. All shrubs and herbs of <i>Dry</i> and <i>Medium</i> types.	Dense <i>Homitelia</i> , <i>Marattia</i> , <i>Todea</i> , <i>Blechnum</i> caneae, under canopy. <i>Spathium</i> , <i>Brachylaena</i> <i>herbifolia</i> , <i>Glechhia</i> polypodioides along the margins and in open sites.	The rough climate of the upper altitudes produces a shorter height-growth, and a squat, asym- metrical form; the crowns are mis- shapen and gnarled. On the more ex- posed sites the mean height of the canopy does not exceed 10 feet. The general physiog- nomy of the vegeta- tion resembles that of coastal Scrub- and Bush; the canopy appears as an inclined plane, the most exposed portion being the lower edge of the plane. REGENERATION EXCEPT THAT OF CUNONIA, IS SPARSE OR ABSENT.

## NOTE TO TABULAR STATEMENT.

*Montane* Forest is merely a habitat form of the *Moist* type. The Forests of this type are principally of value as *protection Forests*; the timber in them is of little value.

• *Vide* Phillips, 1928 (6); 199-200.



## Chapter VIII.

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SUMMARY OF SUCCESSION AND REACTION  
TENDENCIES.





## CHAPTER VIII.

## SUMMARY OF SUCCESSION AND REACTION TENDENCIES.

## (a) SUCCESSION TENDENCIES.

A study of the development of vegetation within the Knysna region reveals the following features of interest and of importance:—

(1) The Temperate-form of Subtropical Forest and the Macchia or “ Fijnbos ” are the two formations within the region. Of these, the Forest formation is the more important in that it at one time must have been exceedingly more extensive than the Macchia, and in that the natural tendency is for it to develop or re-develop on ground held by the Macchia. Devastation by fire has diminished the area of the Forest formation very considerably.

(2) Forest is either the *actual*\* or the *potential* climax on all portions of the plateaux, the *potential* climax on the greater portion of the foothills of the barrier-range, and the *actual* climax in certain montane valleys. Macchia is sub-climax on the greater portion of the mountain slopes and the climax on the summits; it is also climax on small portions of the foothills. Owing to the agencies of fire and exploitation much land on the plateaux and foothills is bearing Macchia of *seral* nature: a stage in the succession to Forest.

(3) The important seres (Hydrosere, Lithosere, Psammosere) converge on Macchia or on Scrub.

(4) The Macchia is of three types: *Hygrophilous*, *Lithophilous*, *Psammophilous*. Any of the types may remain climax, and any of them may develop to Scrub, Bush, or Forest.†

(5) On account of fire, migration barriers (physical and biotic), reaction of vegetation, competition, and soil conditions, Macchia actually of *seral* nature, Scrub, and Bush may remain in *subclimax* condition.

(6) With reference to the Forest formation, the following *potential* climaxes, or *post-climaxes*, are indicated by a study of *mesoclines*‡ and *xeroclines*|| (Clements 1924: 75) and of vegetation zones and alternates in the region, and of vegetation zones exterior to the region:—

(a) Were the climatic conditions to become slightly drier, the drier type Forest would become climax; were the change toward drier conditions more marked, Bush would terminate the succession; were the change still greater, semi-karroid Scrub would take the place of Forest as the climatic climax.

(b) Were the climatic conditions to become slightly moister, Forest of more hygrophilous nature, composed largely of *Platylophus*, *Cunonia*, *Ilex mitis*, *Brachylaena uerifolia*,

\* *Actual*, i.e. *actually* existing in climax form.

*Potential*, i.e. having the power of developing to the climax—e.g. forest may not *actually* occur but the area may possess the *potential* for its production.

† According to the climatic and soil conditions.

‡ Moist, cool slope, regardless of exposition.

|| Dry, warm slope, regardless of exposition.

Sparmannia and Ferns, would form the climax; were the change in the direction of still greater humidity, luxuriant hygrophilous Macchia would form the climax in all probability.

(7) As the succession advances, the vegetation becomes richer in subtropical species of probable tropical ancestry. Bews (1920: 387-388) describes this condition for the coast belt of Natal, and formulates a "Law of Succession": "*In a subtropical region, as the succession advances, the vegetation becomes more and more tropical.*" It is interesting to note that in a region much nearer the temperate than Natal, a *temperate* flora—the South-western—yields ground to a *subtropical*, as the succession advances: Macchia is replaced by Forest.

(8) As the succession advances, the vegetation becomes less xerophytic: Macchia plants rich in ericoid forms yield place to slightly less xerophytic broad-leaved forms, and the latter to still less xerophytic, broad-leaved Forest forms.

(9) Bews (1920: 450) is of opinion that animal agencies (notably insects attacking seeds) may "*prove more potent than the climatic in leading to changes in the climax phase. In other words, the climax type of vegetation may change without any change in the climate.*"—At the Knysna, despite the careful study of the influence of animal and fungous pests, there is no evidence that biotic agencies can change the nature of the climax: at most they are responsible for originating subseral succession. Climate everywhere controls the climax, which is in equilibrium with it.\*

(10) As held by Clements (1916: 145 et seq.) for vegetation in general, succession is found to be everywhere *progressive*; no instance of *regressive* succession, or so-called *degeneration*, has been detected. Disturbing agencies everywhere account for examples of seeming regression.

(11) In burn subseries an important role is played by *Virgilia capensis*, which is endemic to the coastal region commencing at the Cape Peninsula, and ending 20 miles West of Port Elizabeth, but as pointed out by Phillips (1926: 3) it is by no means the only pioneer. The hypothesis of Schönland (1924: 456-57) that were the species to disappear, the forests of the Knysna would automatically disappear, is not supported in fact.

(12) There are floristic and successional reasons for assuming that the Forest climax, so far from being a *decadent* one, is one filled with vitality and possessing great potential.

(13) Selective exploitation (*vide* Chapter 3: p. 103) of certain Forest tree species is producing appreciable changes in the *percentage frequency* of stems of Forest spp. The tendency is for *Podocarpus* spp., *Olea laurifolia* (which spp. do not coppice), and *Apodytes* (which coppices poorly) to be reduced in number, in contrast to other less-valuable timber spp., and such free-coppicing spp. as *Ocotea*, *Curtisia*, and *Platylophus*.

#### (b) REACTION TENDENCIES.

*Reaction* (Clements, 1904: 124; 1905: 256; 1916: 80-97) may be defined as *the effect of a plant or plant-community upon its habitat.*

\* See Phillips, 1930; (1) for an account of biotic communities in the Knysna region.

As the succession proceeds toward Forest, the principal reaction tendencies are as follows:—\*

### 1. *Reactions on the Aerial Factors.*

#### 1. *Reaction upon Light.*

All communities except the very earliest of the pioneer stages, reduce the light-intensity considerably. In all seres the tendency is toward increased reduction of light available to seedlings of the youngest stages, the lowest values ( $1/500$ – $1/1500$ ) being found under dense *Macchia*. On the *Macchia* yielding place to *Virgilia* communities, or to the *hygrophilous small tree and shrub stages* of the *Hydrosere*, the light-intensity at ground level is appreciably increased, the values ranging from  $1/15$  (*Virgilia* communities) to  $1/500$  (Scrub). The reasons for this increase are to be found in the disappearance of much of the dense under-growth of the *Macchia* consequent to its being shaded by the *Virgilia* and small tree stages, and in the opening up of the community as the result of the invasion by Scrub forms. Once the tree and Scrub stages develop to Bush or Forest, the intensity again decreases steadily on account of the formation of various layers. In ordinary high Forest the light values at ground level and at heights of from 20 to 50 feet, are low (*vide* Table XVIII, Chapter 2).

Altogether apart from unfavourable edaphic or biotic conditions prevailing in the community, the absence of regeneration in its various stages, or the poor growth of such regeneration as does exist, is to be attributed to insufficiency of light. Experiments in natural forest and under controlled field conditions alike show that degree of establishment would be considerably higher, and that rate of growth of the resultant seedlings would be many times faster, were better conditions of illumination available. At the present time the shade-tolerance of some seedlings of some spp. (e.g. *Olea laurifolia*, *Elaeodendron croceum*, *Ocotea*, *Apodytes*, and *Podocarpus* spp.) is remarkable. Some of the young plants put on absolutely no height or girth increment in the course of several years, and at the ages of 2 to 4 years are but several inches high, yet they continue to live. A decade later they may be several inches higher. From studies of the increments of young, of semi-adult, and of adult forest trees at the Knysna, it seems evident that one of the most potent causes of the slow rate of maturation in undisturbed primeval forest, is the inadequate light-supply available until such time as the trees have grown tall enough to pierce the canopy with their crowns. It is to be noted too, that even trees the crowns of which form the upper canopy of the forest, receive greatly diminished supplies of light owing to the close lateral packing. The poverty of herbaceous forms in Bush and Forest is a direct result of the low light intensity, these forms occurring on open sites and along the margins only.

The study of reaction upon light has already suggested various sylvicultural methods\* likely to be useful in the management of the indigenous Forests, and the further study of this important subject is expected to return many data of scientific and practical value.

\* For a detailed summary of reaction data yielded by experiment, see Phillips, 1927 (6); 1927 (8).

† *Vide* Appendix 3 for a general account.

## (2) *Reaction upon Humidity, Temperature, and Wind.*

Following Clements (1916:94.) the factors Humidity, temperature and wind are treated together for the reason that they are linked because of their influence upon transpiration, and upon evaporation of soil moisture.

Measurements of humidity, temperature (air, surface-soil, sub-soil) and observation of wind, under several communities show that as the succession advances, each factor is separately reacted upon.

Thus there is a steady increase in humidity (i.e. a decrease in saturation deficit) in all communities (except the hydrosere, which for a period exhibits reduction in humidity as the sere advances, but later, an increase in common with the communities of the Psammosere and Lithosere), a steady decrease in temperature of air, surface-soil, subsoil, and a steady decrease in mean wind force. In consequence of these influences upon the single factors, the factor-complex formed by their integration, is also modified, the tendency being for the development of highly humid, cool, still conditions favouring reduced rates of transpiration and evaporation, under the canopy of the climax community. The dominants of that community naturally do not themselves fully participate in these optimum conditions, for their crowns are exposed, to some extent, to the rigours of the open atmosphere.

The most important periods in reaction upon the aerial factor-complex are, firstly that during which the pioneer stages first form a close cover over the soil, and secondly that in which *Macchia* is ousted by Scrub or Bush. The formation of layers within the Forest intensifies the reduction of humidity, temperature and wind, the moistest, coolest, stillest conditions prevailing just above the soil. In undisturbed Knysna Forest, owing to the large number of layers and the general continuity and closeness of such layers, interruptions in the general humidity, coolness and stillness are not met as the height above ground is increased. The conditions in British woodland, according to Salisbury (1925: 337-338) are different, on account of the comparatively even height development of ground flora, shrub layer, and tree layer over considerable areas, thus bringing about abrupt changes in aerial conditions according to height above ground. Adamson's (1912: 354) evaporation data: At level of the ground flora 142 c.c., immediately above the latter 176 c.c., in the shrub canopy 149 c.c., above the latter 182 c.c., support Salisbury's remarks. In typical Knysna Forest the evaporation curve shows a steady rise from below upward.

## 2. *Reaction on the Edaphic Factors.*

The material for an entirely new soil may be formed by pioneer hydrosere, lithosere and halosere communities, which materials later communities naturally considerably augment and modify. Thus hydrosere and halosere communities form a semi-stable or stable substratum from free water surfaces, and the lithosere a soil-covering for the originally bare rock surfaces. At the same time, existing soils are variously changed by plant reactions; thus the arid, unstable sands of the shore are firstly fixed, then given body by increased humus content, holard and chemical salts by the stages of the Psammosere; later stages of the Hydrosere continue to reduce

the moisture content, and to add body to the substratum; later stages of the Halosere reduce the moisture content and salinity, and add body to the soil they occupy; finally later stages of the Lithosere increase the depth, holard, humus and salt content of the poor soil covering produced by the pioneer communities.

The reactions by which the new soil is formed or the original soil is modified, are:—

(a) *The accumulation of plant remains* almost entirely under either salt or fresh water, the remains being those of members of haloseral and hydrosere communities; added to these plant remains is much aeolian and water-borne material accumulated as a result of interception by the plant communities. The formation of a fair proportion of the soils of the plateaux, and of low-lying areas near the coast, has been commenced in this manner. Extensive peat formations in Europe have been built up in this manner in the course of the ages.

(b) *Formation by plants of soil from rock*.—Plants actually decompose sheet rock, and in addition add to the number and the size of the cracks in the latter, through action of their roots and stems. Cyanophyceae, Bryophyta, Lichens and chomophytes commence the operation, and are relatively soon assisted by Lithophilous *Macchia* plants and by pioneer Scrub shrubs.

(c) *Collection of aeolian and alluvial sand and finer particles* principally by early stages of the Psammosere and Hydrosere respectively, while gravel slides are arrested by pioneers of the Lithosere, especially along the faces of the barrier-range.

(d) *Addition of organic matter* resulting from the decomposition of the bodies of whole plants, and of foliage, twigs and fruits cast by plants. The main actions of humus are to lighten heavy soils by improving the porosity, and to give body to light soils. The holard capacity is decreased in the first type, and increased in the second. The general tendency, however, is for the holard to increase as the humus content increases, *the total available water content* (chresard) naturally does not increase in direct relation with the humus increment. The tendency is for the percentage of humus to increase as the succession progresses in all series, except the Hydrosere. In this sere the humus content increases to a stage (e.g. the *Platylophus* communities) and thereafter it decreases somewhat.

There is little doubt that in certain communities (e.g. the *Platylophus* consocieties) the continued addition of humus to the soil supporting them, is detrimental to their own regeneration.

(e) *Indirect increase of water content of soil*.—As pointed out by Clements (1916: 88), there appears no case in which plants, apart from *Sphagnum*, increase the water content of a soil as a *direct* reaction, but their *indirect* influence in this direction is of fundamental importance. The increase of water content is brought about through the addition of humus accompanied by decreased rates of evaporation, run-off, and seepage. The tendency is for the available moisture to increase as the succession progresses. Occasionally, examples are found where the available water actually decreases as the succession advances, for the reason that addition of humus and

decreased losses due to evaporation, run-off and seepage, have produced super-saturated moisture conditions in the soil. Thus the dense *Hemitelia capensis* layers in moist Forest, in the course of time, bring about such a state. Removal of the ferns results in a drop in holard and an increase in chresard.

(f) *Decrease of water content of soil.*—In exceedingly closely-stocked Forest, it is found that during dry periods the holard may be very considerably reduced, indeed to such an extent that young regeneration may disappear entirely. In the drier types of climax Forest rich in *Olea laurifolia* and in layers of the moisture-filching *Trichocladus crinitus*, the latter plant although almost completely protected by the canopy of the trees, uses up such considerable quantities of water that it not only precludes successful growth of tree seedlings, but in periods of drought, actually dies back itself, owing to decreased holard conditions.

The action of some of the large trees (e.g. *Podocarpus* spp. and *Olea laurifolia*) is to drain the upper 6-12 inches of soil of most of its moisture, in dry periods. The part played by the exotic *Acacia melanorhylon* in this connection, is described in Appendix II.\*

(g) *Prevention or limitation of processes of soil denudation and desiccation.*—Plant covering limits or prevents denudation by water, and wind, leaching out of highly soluble solutes, the dispersal of fine particles by wind, and the loss of organic matter. In addition the moisture content is usually conserved, and the soil organisms are protected. Removal of the cover results in general deterioration of physical, chemical, and biotic qualities of the soil, unless unduly close conditions of stocking (e.g. moist high Forest rich in ferns; the *Platylophus* communities; dense *Macchia*) exist. Owing to the nature of the soil and the high rainfall experienced in the region, losses through denudation and desiccation are extremely high wherever the plant covering is removed through excessive grazing, careless agriculture, and severe burning.

(h) *Improvement of the aeration and texture of harder and heavier soils of the region.* is brought about by ramification through them of roots and rootlets of plants, more particularly of shrubs and trees. On the other hand, pure, loose sand and sandy soils are bound into more homogeneous states through the arresting action of roots and rootlets of pioneers communities of the *Psammocere* coastal and inland.

(i) *Addition of nutrients.*—Large quantities of mineral salts are returned to the soil as a result of fall of foliage and other plant parts, and the decomposition of dead plants. The use of solutes by the plants, on the other hand, sets up a constant drain upon the supplies available. Judging from the results of determinations of total available soluble salts, of soils from pioneer, medial and climax communities in the same sere, there is a *very slight increase* in soluble food materials as the succession progresses toward Forest.

(j) *Changes in Hydrogen-ion concentration of the soil solution.*—The details of change vary with soil type and with sere. Owing to the accumulation of organic matter, the acidity increases in the

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\* See Phillips 1928 (1).

Psammosere and the Lithosere, until the Macchia stages are reached, after which there is a steady decrease as Forest develops. In the Hydrosere, examples of increasing acidity from the commencement of the sere are known to occur; on the other hand, after the initial stages, the reaction is usually in the direction of decreased acidity. The subject of pH values is referred to in Chapter I (pp. 28-32).

(k) *Soil organisms in symbiosis with certain plants*.—Organisms living in symbiosis with the roots of plants have a direct reaction upon the soil. At the Knysna, for example, in the Macchia the well-represented Leguminosae, containing the various strains of *Pseudomonas radicicola* in their root-nodules, materially influence the production of nitrogen. In the Forests, a strain of the same organism occurs on the roots of *Podocarpus* spp.: Two important species. (*vide* Chapter 1, p. 33.)

From the above summary of reaction tendencies at the Knysna, it is readily seen that the vegetation of Macchia and Forest has had, and is continuing to have, an influence far-reaching and important, upon the climate and soils of the region.





## Chapter IX.

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GROWTH-FORM CHARACTERISTICS  
and  
RATE OF GROWTH OF THE MORE IMPORTANT  
SPECIES OF TREES.



## CHAPTER IX.

## GROWTH-FORM CHARACTERISTICS, AND RATE OF GROWTH OF THE MORE-IMPORTANT SPECIES OF TREES.

## (a) GROWTH-FORM CHARACTERISTICS.

Several of the characteristics—nature of foliage, occurrence of spines, thickness of bark, and development of coppice shoots—of South African Forest trees have been referred to by Bews (1925: 56-61). It is desirable, however, to describe these characteristics so far as the Knysna Forests are concerned, and in addition to deal with other important features hitherto undescribed, the principal of which is that of root-shape and root-depth.

1. *Average dimensions of the principal Forest species.*

The average maximum heights attained by the species are as follows:—

Layer.	Average Maximum Heights in Feet. (Top of Crowns.)	Species.
1	100-120 (trees 140 feet full height are known)	<i>Podocarpus elongata</i> L'Herit.
2	60-90	<i>Podocarpus Thunbergii</i> Hook.
3	50-70	<i>Olea laurifolia</i> . <i>Ocotea bullata</i> . <i>Apodytes dimidiata</i> . <i>Ilex (capensis) mitis</i> . <i>Ekebergia capensis</i> . <i>Pterocelastrus variabilis</i> . <i>Myrsine melanophloeos</i> . <i>Olinia cynosa</i> . <i>Curtisia faginea</i> . <i>Kiggelaria africana</i> (rarely). <i>Faurea McNaughtonii</i> .
4	30-50	<i>Elaeodendron croceum</i> . <i>Nuxia floribunda</i> . <i>Calodendron capense</i> . <i>Plectronia obovata</i> . <i>Plectronia Mundtii</i> . <i>Celastrus acuminatus</i> . <i>C. peduncularis</i> . <i>Royena lucida</i> . <i>Gonioma Kamassi</i> . <i>Olea capensis</i> . <i>Olea foveolata</i> . <i>Rhus laevigata</i> . <i>Cussonia umbellifera</i> . <i>Virgilia capensis</i> . <i>Fagara Davyi</i> . <i>Pygeum africanum</i> .

Layer.	Average Maximum Height in Feet. (Top of Crown.)	Species.
5	Under 30	<i>Toddalia lanceolata</i> .* <i>Celtis rhamnifolia</i> . <i>Lachnostylis capensis</i> . <i>Halleria lucida</i> . <i>Chilianthus arboreus</i> . <i>Tarchonanthus camphoratus</i> . <i>Ochna arborea</i> . <i>Gardenia Rothmannia</i> . <i>Burchellia capensis</i> . <i>Brachylaena dentata</i> . <i>Pittosporum viridiflorum</i> . <i>Ficus capensis</i> . <i>Royena pallens</i> (forest form). <i>Sideroxylon inerme</i> . <i>Elacodendron Kraussianum</i> . <i>Scolopia Mundtii</i> . <i>S. Zeyheri</i> .
6	Under 20, over 8	<i>Trichocladus crinitus</i> . <i>Trichocladus ellipticus</i> . <i>Celastrus buxifolius</i> . <i>Rhamnus prinoides</i> . <i>Polygala myrtifolia</i> . <i>Osteospermum moniliferum</i> . <i>Brachylaena nerifolia</i> . <i>Fagara capensis</i> . <i>Euclea macrophylla</i> . <i>Doryalis (Dovyalis) spp.</i> <i>Psychotria capensis</i> . <i>Clausena inaequalis</i> . <i>Hippobromus alata</i> . <i>Plectronia ventosa</i> . <i>Ochna atropurpurea</i> . <i>Rhus lucida</i> and spp.

\* *Toddalia* = *Vepris lanceolata* G. Don.

(Stems of *Hemitelia* 10 feet in height are very abundant in moist Forest.)

The average maximum girths attained by the species are as follows:—

Class.	Average Maximum Girths in Feet. (At 4½ Feet above Ground.)	Species.
1	15-25	<i>Podocarpus elongata</i> L'Herit. Exceptionally large stumps of <i>Ocotea</i> and <i>Platylophus</i> are to be listed in this girth-class; such stumps are usually of short length and are grotesque in shape.
2	6-10	<i>Ocotea bullata</i> . <i>Platylophus trifoliatus</i> . <i>Foutrea McNaughtonii</i> .
3	6-8	<i>Olea laurifolia</i> . <i>Apodytes dimidiata</i> . <i>Ilex (capensis) nuttis</i> . <i>Olinia cymosa</i> . <i>Cunila capensis</i> . <i>Podocarpus Thunbergii</i> .
4	4-6	<i>Pterocelastrus variabilis</i> . <i>Nuxia floribunda</i> . <i>Plectronia obovata</i> . <i>Ekebergia capensis</i> . <i>Cussonia umbellifera</i> . <i>Curtisia faginea</i> .

Class.	Average Maximum Girths in Feet. (At 4½ Feet above Ground.)	Species
5	2½ - 4	<i>Plectronia Mundtii.</i> <i>Celastrus acuminatus.</i> <i>C. peduncularis.</i> <i>Elaeodendron croceum.</i> <i>Kiggelaria africana.</i> <i>Scolopia Mundtii.</i> <i>S. Zeyheri.</i> <i>Calodendron capense.</i> <i>Sideroxylon inerme.</i> <i>Pygeum africanum.</i> <i>Toddalia lanceolata.</i>
6	Under 2½ feet and over 1½.	<i>Celtis rhamnifolia.</i> <i>Lachnostylis capensis.</i> <i>Halleria lucida.</i> <i>Chilianthus arboreus.</i> <i>Tarchonanthus camphoratus.</i> <i>Ocotea arborea.</i> <i>Gardenia Rothmannia.</i> <i>Burchellia capensis.</i> <i>Brachylaena dentata.</i> <i>Pittosporum viridiflorum.</i> <i>Ficus capensis.</i> <i>Royena pallens.</i> <i>Elaeodendron Kraussianum.</i>
7	From several inches to 1½ feet	<i>Trichocladus cernitus.</i> <i>Trichocladus ellipticus.</i> <i>Celastrus buxifolius.</i> <i>Rhamnus prinoides.</i> <i>Polygala myrtifolia.</i> <i>Osteospermum moniliferum.</i> <i>Brachylaena nerifolia.</i> <i>Fagara capensis.</i> <i>Enclea macrophylla.</i> <i>Doryalis spp.</i> <i>Psychotria capensis.</i> <i>Clausena inaequalis.</i> <i>Hippobromus alata.</i> <i>Plectronia ventosa.</i> <i>Ocotea atropurpurea.</i> <i>Rhus lucida and spp.</i> <i>Hemitelia capensis stems.</i>

## 2. Nature of the boles and crowns.

The growth-forms of the more important trees are few: (i) the clean and upright boled, simple-leaved type, with high-set crowns, e.g., *Apodytes dimidiata*, *Ilex mitis*, *Kiggelaria africana*; (ii) the slightly-inclined boled, heavily branched type, with or without simple leaves, e.g. *Cunonia capensis* and *Platylophus trifolius* (compound leaves), *Elaeodendron croceum*, *Nuxia floribunda* (simple leaves); (iii) the *gourmand-coppice* type: naturally-produced coppice surrounding a living or a dead central bole; e.g. *Ocotea bullata*.

These are all primitive types, but probably are not as primitive as that class of single-boled, large, and simple-leaved, sparingly-branched hygrophilous trees (e.g. *Xymalos monospora*, *Bridelia micrantha*, *Macaranga capensis*.) described by Bews. (1925: 49, 58, 84.)

The sole representative of this class at the Knysna is *Ficus capensis*, which in most instances does not form a tree of the class defined, but is a badly-shaped, heavily branched tree or a scandent shrub.

Characteristic features of the boles and crowns are discussed below:—

(a) *Plank buttresses* (Schimper, A. F. W.: 1903: 304-305).—Plank buttresses, or plank-like, or laterally-flattened outgrowths of the base of the trunk and of the uppermost roots, are described by Schimper. (loc. cit.) He considers the plank-buttress as a peculiarity of trees in a tropical climate with abundant rainfall.

While the plank-buttresses shown by several species at the Knysna are by no means as marked as the structures shown by species of *Sterculia*, *Vitex*, *Bombax*, etc., in the tropics, they are sufficiently well defined to attract attention. The species exhibiting the structures, at the Knysna, are to be divided into two classes:—

*Species exhibiting marked plank-buttresses—*

*Ficus capensis*.

*Ilex capensis*.

*Calodendron capense*.

*Pterocelastrus variabilis* (very well defined).

*Elaeodendron Kraussianum*.

*Plectronia Mundtii*.

*Plectronia obovata* (at times very well defined).

*Species exhibiting vestigial plank-buttresses.—*

*Apodytes dimidiata* (at times).

*Ocotea bullata*.

*Olea laurifolia* (fairly well defined at times).

*Gonioma Kamassi* (at times).

*Faurea McNaughtonii* (at times).

*Ekebergia capensis* (at times).

It is interesting to notice that these trees showing buttresses belong to several important families better represented in the tropics of Africa: Moraceae, Aquifoliaceae, Rutaceae, Celastraceae, Rubiaceae, Icacinaceae, Lauraceae, Oleaceae, Apocynaceae, and Proteaceae. The exhibition of buttresses marks these plants as being of probable tropical ancestry.

(b) *Thickness of bark*.—As pointed out by Bews (1925:61) the possession of a thick bark is a feature of a number of South African Forest trees. The more important species occurring at the Knysna may be classified as follows, with respect to thickness of bark:—

Class.	Nature of the Bark.	Species.
1	Very thick: in many instances over $\frac{1}{2}$ inch	<i>Olea laurifolia</i> . <i>Olea foveolata</i> . <i>Olea capensis</i> . <i>Faurea McNaughtonii</i> . <i>Olinia cymosa</i> . <i>Curtisia faginea</i> (older trees). <i>Lachnostylis capensis</i> (older trees). <i>Sideroxylon inerme</i> . <i>Pterocelastrus variabilis</i> . Some old <i>Podocarpus Thunbergii</i> Hk. and old <i>Ocotea</i> .
2	Thick: about $\frac{1}{2}$ inch.....	<i>Apodytes dimidiata</i> . <i>Ilex mitis</i> . <i>Podocarpus</i> spp.* <i>Ocotea bullata</i> . <i>Platylophus trifoliatus</i> . <i>Cunonia capensis</i> . <i>Nuxia floribunda</i> . <i>Scolopia</i> spp.

\* Young *Podocarpus Thunbergii* Hook and medium-sized *P. elongata* L. Herit often have "medium" bark

Class	Nature of the Bark.	Species.
3	Medium; about $\frac{1}{2}$ inch.....	<i>Electronia Mundtii.</i> <i>Electronia obovata.</i> <i>Celastrus acuminatus.</i> <i>C. peduncularis.</i> <i>Elaeodendron</i> spp. <i>Tarchonanthus camphoratus.</i> <i>Pygmaea africanum.</i> <i>Ekebergia capensis.</i> <i>Kiggelaria africana.</i> <i>Toddalia lanceolata.</i> <i>Calodendron capense.</i> <i>Celtis rhamnifolia.</i> <i>Gardenia Rothmannia.</i> <i>Halleria lucida.</i> <i>Burchellia capensis.</i> <i>Brachylaena dentata.</i> <i>Pittosporum viridiflorum.</i> <i>Ficus capensis.</i> <i>Royena lucida.</i> <i>Virgilia capensis.</i>
4	Thin; less than $\frac{1}{2}$ inch; outer bark flaking off, several times per year	<i>Ochna arborea.</i> <i>Ochna atropurpurea.</i>

(c) *Production of spines*.—Spines are not developed to any great extent, and this is to be understood on account of the general moistness of the region.

A point of significance is that drier types of Forest, littoral Forest, littoral Bush and Scrub, and inland Scrub, are infinitely richer in thorny individuals and rather richer in thorny species, than are the medium-moist and the moist Forests.

Spines are exhibited by the following Forest forms:—*Fagara Davyi*, F, *capensis*; *Scolopia Zeyheri*, and at times *S. Mundtii*, especially on coppice; *Electronia ventosa*, *Celastrus buxifolius*, *C. nemorosus*, *Cassinopsis capensis*, *Carissa arduina*, *Scutia indica*, *Caparis citrifolia*, *Niebuhreria pedunculosa* (at times), *Rubus pinnatus*, *Davyalis rhamnoides* and *Asparagus* spp.

(d) *Cauliflory*.—The production of flowers and fruits from the old wood of branches and stems is rare, the only species exhibiting it being *Halleria lucida*, *Ficus capensis*, and *Ficus Burt-Davyi*. *Halleria lucida* is of interest in that flowers arising from one and the same portion of the wood of the same tree, in different seasons, may be of different colours: brick-red, white, or creamish. The development of the dormant axillary buds that burst through the cortex, and form the clusters of flowers, is studied readily in this species.

*Cauliflory* is a not uncommon feature of tropical Forest, and it is a little surprising to find that it is not better exhibited in the humid Kynsna forests.

(e) *The production of Coppice shoots and of natural Layers*.—Coppice-producing species are numerous, and fortunately so, for the capacity of these species for reasserting themselves after being felled or burned, has had a great deal to do with the preservation of the Forest limits. Freely-coppicing forms are as follows:—

*Ocotea bullata*, *Canonia capensis*, *Platylophus trifolius*, *Apydites dimidiata* (often do not form good boles), *Curtisia laginea*, *Gonioma Kamassi*, *Olinia cymosa*, *Hex mitis*, *Nuxia floribunda*, *Kiggelaria africana*, *Scolopia Mundtii*, *S. Zeyheri*, *Royena lucida*, *Myrsine melanophleas*, *Halleria lucida*, *Electronia* spp., *Burchellia*



capensis, *Rhus laevigata*, *Celtis rhamnifolia*, *Lachnostylis capensis*, *Tarchonanthus capensis*, *Ochna arborea*, *Faurea McNaughtonii*, *Vepris* (*Toddalia*) *lanceolata*, and *Ekebergia capensis*.

The rate of growth (in height and in girth alike) of coppice is appreciably greater than that of normally rooted stems, species for species. The coppice shoots flower and fruit normally. Coppice springing from portions of the stem more than 6 to 8 feet above the ground are frequently dislodged by strong wind, but those nearer the soil within several years form their own roots from dormant buds, and on the death of the parent stem, find themselves as independent individuals. It is fortunate that such valuable timber species as *Ocotea bullata* (Stinkwood), and *Platylophus trifolius* (Witte Els), which produce relatively few viable germules (*vide* Appendix I) produce fast-growing, vigorous coppice.

The natural production of *layers*, that is of procumbent branches that strike root and form additional stems as time goes on, is not common. The species forming layers are:—*Platylophus trifolius*, *Cunonia capensis*, and sometimes *Ilex mitis*; *Gonioma Kamassi* principally propagates itself by means of *layers*.

(f) *Crown types*.—The crowns of the more important species may be classified in the following manner:—

Crown Type.	Species.
Crowns conical in sapling and pole stages	All species.
Crowns conical in adult stages.....	<i>Pterocelastrus variabilis</i> ; <i>Plectronia Mundtii</i> ; sometimes <i>P. Thunbergii</i> ; <i>Gardenia Rothmannia</i> .
Crowns conical in semi-adult stages.....	<i>Ocotea bullata</i> ; <i>Podocarpus Thunbergii</i> Hook; <i>P. elongata</i> L'Herit.
Crowns egg-shaped (point downward) in adult stages	<i>Podocarpus Thunbergii</i> .
Crowns umbrella-like or umbelliform.....	<i>Cussonia umbellifera</i> .
Crowns springing from semi-decumbent or strongly inclined boles; crowns variously shaped	<i>Nuxia floribunda</i> ; <i>Platylophus trifolius</i> ; <i>Elacodendron croceum</i> .
Crowns inverted broom-shape, horizontally extended, with strong branches	<i>Olea laurifolia</i> , <i>O. capensis</i> , <i>O. foveolata</i> ; <i>Ocotea bullata</i> (adult stage); <i>Apodytes dimidiata</i> ; <i>Ilex mitis</i> ; <i>Ekebergia capensis</i> ; <i>Myrsine melanophloeos</i> ; <i>Olinia cynosa</i> ; <i>Curtisia faginea</i> ; <i>Kiggelaria africana</i> ; <i>Faurea McNaughtonii</i> ; <i>Caledondron capensis</i> ; <i>Plectronia obovata</i> ; <i>Celastrus acuminatus</i> ; <i>Celastrus peduncularis</i> ; <i>Roxena lucida</i> ; <i>Gonioma Kamassi</i> (adult stage; conical in semi-adult stages); <i>Rhus laevigata</i> ; <i>Virgilia capensis</i> (adult stage only); <i>Fagara Davyi</i> ; <i>Pygeum africanum</i> ; <i>Toddalia lanceolata</i> ; <i>Celtis rhamnifolia</i> ; <i>Lachnostylis capensis</i> ; <i>Halleria lucida</i> ; <i>Tarchonanthus camphoratus</i> ; <i>Ochna arborea</i> ; <i>Sideroxylon inerme</i> ; <i>Scolopia</i> spp.

### 3. *Nature of the foliage.*

Practically all the species at the Knysna are *ever-green*, the same leaves remaining in position for periods of several years. (Marked leaves, freshly produced, have been kept under observation for several years at Deepwalls.) The leaves become more and more leathery with age, and assume abnormal shapes; they are much galled by Diptera and other insects, and are clad with minute Lichens.

*Deciduous* species occurring are *Kiggelaria africana*, *Calodendron capense*, *Ekebergia capensis*, *Plectronia Mundtii*, *Ficus capensis*, *Rhus laevigata*, *Celtis rhamnifolia*, and *Heteromorpha arborescens*, while in dry seasons *Virgilia capensis* may shed many of its leaves. Certain individuals of *Clauseria inaequalis* and *Hippobromus alata* shed their leaves, while others retain them.

The species above listed do not systematically lose their foliage in the winter—they appear to be influenced more by the nature of the season than by the time of the year, thus in dry years they may lose all their leaves once or several times, while in abnormally moist years they may cast but portion of their foliage, or may remain fully foliated for the entire year. The same species further East, in the Forests of Alexandria and the Amatola Mountains, are more regularly deciduous.

The leaves are in most instances simple, the exceptions being the trifoliate *Rhus laevigata*, *R. lucida*, several minor *Rhus* spp., *Allophylus erosus*, *A. decipiens* Vepres (*Toddalia lanceolata*), *Platylophus trifolius*, the 3-7-foliate *Cussonia thyrsiflora*, the 5-7-foliate *Cussonia umbellifera*, the variable *Heteromorpha arborescens*, and the pari—or impari—pinnate *Fagara Davyi*, *F. capensis*, *Ekebergia capensis*, *Virgilia capensis*, *Schotia latifolia*, *Cassia tomentosa*, *C. occidentalis*, *Clauseria inaequalis*, *Hippobromus alata*, and *Cononia capensis*. The proportion of species with compound leaves is thus a very small one. If there be a correlation between the humidity of the habitat and leaf division—and Bews's work with *Bidens pilosa* in this connection is suggestive and interesting (Bews and Aitken: 1925: 53)—it is readily understood why forms with divided leaves are rare at the Knysna, with its highly humid conditions of atmosphere and soil. Within the Knysna region it is noticeable that with the exception of *Platylophus*, *Cononia*, and *Virgilia*, the divided-leaved forms are more numerous in the drier Forest types, and in Bush and Scrub, than they are in the moister types.

Macroscopic and microscopic study of the leaves of the principal tree species has revealed the following features of importance:—

The so-called *drip-tip form* is absent, *pubescent-coverings* are all but so (*Trichocladus crinitus* a shrub of the lower layers, and the trees *Royena lucida* and *Curtisia faginea* possess leaves villose on their ventral surfaces, while *Buddleia salviaefolia*, a rambling shrub of the margins, is protected on its ventral leaf surface by rusty pubescence), the smooth, glabrous forms prevailing.

Distinctly *varnished surfaces* do not occur, although there is an approach to the varnished condition in the upper surfaces of the leaves of *Royena lucida* and *Rhamnus prinoides*, and occasionally of *Scolopia* spp.

While the *cuticle* is fairly well developed on both surfaces, there are no forms with stomata sunk more than a very slight degree below the general level of the ventral surface. *Stomata* occur on the under surfaces of the leaves of all the Forest species; in *Podocarpus elongata* L'Herit, they occur on both dorsal and ventral surfaces. No peculiar stomatal mechanism has been observed. The development of *epidermal layers* is quite normal, there being slight traces of *hypoderm* in several species (e.g. in *Cunonia*, *Platylophus* and *Ocotea*) only. The *palisade* is usually 2-3 layered; no special water retaining cells are present; *crystal-sacs* are fairly well represented, oil vesicles less so. There is a strong development of *sclerenchymatus strengthening tissues* in the leaves of all the species. Anatomical details are given for some species (e.g. *Olinia*, *Cunonia*, *Polygala myrtifolia*, *Olea capensis*) by Knoblauch (1896) and for others (e.g. *Ocotea*, *Gonioma*, *Olea* spp., *Curtisia*, and *Nuxia floribunda*, etc.) by Gerhard (1902).

Experimental work at Deepwalls Research Station is showing the ready response made by the foliage of the more important Forest tree species [e.g. *Ocotea*, *Platylophus*, *Cunonia*, *Curtisia*, *Olinia cymosa* (Phillips, J. F.: 1925: (2): 211), *Podocarpus* spp., *Faurea McNaughtonii*, *Virgilia capensis*, *Olea laurifolia*, *Apodytes dimidiata*] to changes in prime aerial factors: Light-intensity, humidity, temperature. Indeed the structural response of the tissues of the leaves of several of the species above-mentioned is sufficiently delicate to encourage the writer with the hope that young plants of the species may be used as phytometers. Field observations show that the same species exhibits foliage differing in external appearance and dimensions, and in internal appearance and dimensions, according to nature of the habitat; species particularly interesting in this connection are *Olea capensis*, *Apodytes dimidiata*, *Celastrus acuminatus*, and *Podocarpus elongata* L'Herit. A systematic study of these habitat-forms or ecads is likely to lead far toward the solution of the problems of evolutionary history of South African Forest forms.

#### 4. Root depth and root form.

A study of the root-systems of the Forest species of the Knysna has been made, utilizing as material the roots exposed in the processes of road-making in the Forests, and of exploitation. Special vertical quadrats or bisects, have been made from time to time. As no previous study of these important subjects has been made, the summary given below will be of particular interest to South African foresters and ecologists.

Owing possibly to the high rainfall and to the even distribution of that fall, the root-systems are remarkably shallow when the size of the trees is taken into consideration, and when the root depths of somewhat smaller European trees are remembered. The average maximum depth of penetration is  $3\frac{1}{2}$  feet; exceptional penetrations of from 4 to 6 feet have been encountered, but these are rare.

The various species naturally differ as to the depth of penetration, and one species may penetrate deeper in one type of locality than it will in another. Depth of soil, nature of the substratum, aspect, degree of slope, and the nature of the Forest community are found to be factors that play important parts in deciding how far one and the same species may penetrate.

The species of importance may be classified according to depth of occurrence of the general root-system, in the following manner:—

Zone.	Description of Zone.	Species.
1.	The shallowest; from 12-18 inches	<i>Olea laurifolia</i> (the shallowest tree of large dimensions, in the Forest); <i>Ficus capensis</i> .
2.	Medium-shallow; from 18-24 inches.	<i>Platylophus trifolius</i> (has extensive laterals; <i>Ilex mitis</i> ).
3.	Medium-deep; from 24-30 inches....	<i>Podocarpus Thunbergii</i> ; <i>P. elongata</i> L'Herit. (has very extensive laterals of large dimensions; very large trees of this sp. have roots falling within Class 4) <i>Nuxia floribunda</i> ; <i>Cononia capensis</i> , <i>Fagara Davyi</i> ; <i>Virgilia capensis</i> ; <i>Olinia cymosa</i> ; <i>Kiggelaria africana</i> ; <i>Scolopia</i> spp.; <i>Halleria lucida</i> ; <i>Burchellia capensis</i> ; <i>Ochna arborea</i> ; <i>Royena lucida</i> ; <i>Plectronia mundtii</i> ; <i>Faurea McNaughtonii</i> , <i>Gonioma Kamassi</i> , <i>Ekebergia capensis</i> .
4.	Deepest from 30-42 inches.....	<i>Apodytes dimidiata</i> ; <i>Ocotea bullata</i> ; <i>Plectronia obovata</i> ; <i>Curtisia laginea</i> ; <i>Celastrus acuminatus</i> ; <i>Celastrus peduncularis</i> ; <i>Pterocelastrus variabilis</i> ; <i>Elaeodendron croceum</i> . <i>Very large</i> <i>Podocarpus elongata</i> L'Herit.

The form of root-system does not show very much variation, at the Knysna, but at the same time the species may be classified under several headings. A glance at European tree root-systems is helpful in describing the conditions at the Knysna. European species may be classified somewhat as follows:—\*

Class.	Form of Root-system.	Examples.
1.	Flat, horizontal	<i>Picea excelsa</i> .
2.	Flat, with off-shoot roots descending like sinkers	<i>Salix</i> and <i>Populus</i> spp.; <i>Betula</i> and <i>Abus</i> .
3.	Deep, heart-shaped roots, with long laterals	<i>Ulmus</i> , <i>Acer pseudoplatanus</i> ; <i>Tilia</i> , <i>Fraxinus</i> .
4.	Tap roots persisting throughout life	<i>Quercus</i> , <i>Castanea</i> , <i>Juglans</i> .
5.	Tap roots persisting for a time only, according to locality	<i>Ulmus</i> , <i>Acer pseudoplatanus</i> ; <i>Lixium</i> .

While the Knysna species do not *exactly* fall into any of the above classes, they at the same time approach the types defined, to some degree.

*Class 1* is not represented.

*Class 2* includes *Olea laurifolia*, with the difference that the off-shoot roots do not descend vertically, but go off at angles of from 30-45 degrees. *Ficus capensis*, *Ilex mitis*, and *Platylophus trifolius*, too, fall under this description.

*Class 3*, with the modification that the long laterals are more extensively developed than they are in the European species, and that they leave the main heart-shaped root-mass at points nearer the surface, includes the following Knysna species:—

*Adult forms* of *Podocarpus* spp.; *Nuxia floribunda*; *Cononia capensis*, *Fagara davyi*, *Virgilia capensis*, *Olinia cymosa*, *Kiggelaria africana*, *Scolopia* spp.; *Halleria lucida*, *Burchellia capensis*; *Ochna arborea*; *Royena lucida*; *Plectronia mundtii*; *Plectronia obovata*; *Faurea McNaughtonii*; *Gonioma Kamassi*, *Ekebergia capensis*.

\* According to E. P. Stebbing.

*Class 4* has no representatives apart from an occasional *Ocotea bullata*.

*Class 5* has the following species:—

*Apodytes dimidiata*; *Ocotea bullata*; *Curtisia faginea*; *Celastrus acuminatus*; *C. pedicularis*; *Pterocelastrus variabilis*; *Elaeodendron croceum*.

A detailed description of the nature of the smaller roots of the various spp. is not possible here, but they may be described in general as being strong, pliable, fibrous, and abundantly developed. Portions or forest examined have yielded as much as  $1\frac{1}{2}$ -3 lb. dry-weight (oven-dried at 105 deg. Cent. to constant weight) of root-mass (no root over  $\frac{1}{4}$ -inch being included) per square metre, to a depth of 12 inches. This gives some impression of the dense development of the finer roots and rootlets.

#### (b) Rates of Growth.

The South African forest trees are considered *extremely slow-growing* by foresters, and the measurements of girth-increment taken in undisturbed forest or in long-rested, lightly felled forest, certainly support their view. It must be remembered, however, that temperate, tropical, and other subtropical forest trees, too, under primeval conditions of canopy and stocking, grow less fast than they do under silvicultural management or in plantation form.

The Knysna species show better increment when the Forest in which they occur is systematically thinned and tended. At all events, the rotation required for the *commercial* maturation of the slowest even of the species, probably will not be as long as that adopted in the French Forests of Allier, for prime Oak: 280 to over 300 years.

##### 1. Girth Increment.

The method of measurement of girth-increment adopted by the writer in the study of about 15,000 trees of various sizes from several inches in girth to over 60, is as follows (vide Plate 79):—

A  $1\frac{1}{2}$ -2-inch-wide band is carefully painted round the circumference of the bole, at about  $4\frac{1}{4}$  feet above ground, after initial removal of old bark, lichens, etc. The lower edge of the band is made as even as possible by means of a sharp knife. The upper edge of a standard steel tape reading to 16ths of an inch is placed along this even edge, and the girth thus read. The tree is remeasured annually. Dendrographic studies are showing that the degree of error resulting from the reversible variation of the diameter of the bole and from expansion due to rising temperature, is beyond the limits of practical measurement, amounting to less than 1 10th of a millimetre in the largest trees.

The summary of girth-increments by girth-classes for a number of the more important trees, growing in Exploited Forest, in Exploited and Tended Forest, and in Natural Forest, given in *Table XLIII* is based upon data collected from 19 2-acre increment areas situated in various portions of the Knysna Forests. It is seen that as a general rule the increments are larger in Forest that has been opened up by exploitation than they are in normal Unexploited Forest, while those shown by opened-up and tended Forest are slightly greater than those for Forest exploited but not tended.

For sake of demonstrating the degree of growth taking place on a definite portion of Forest in one year, the annual increment shown by the several girth-classes of the main species occurring on an area of 2 acres, in Forest of medium holard, at Sourflats, is given in *Table XLIV*.

A summary of increment exhibited by certain species growing in Littoral Bush is given in *Table XXXII*, Chapter 5.

Dendrographic studies of diameter growth of several of the more important species by means of a MacDougal Dendrograph (MacDougal, D.T.: 1918; '19; '20; '21; '24; '25) have been commenced. The daily reversible variations described by MacDougal (op. cit.) are exhibited; the diameter being least during the driest, warmest period of the day, and greatest during the very early hours of the morning. Examples of Dendrograms for *Olinia cymosa* Thunb., and *Ocotea bullata* are given in Chapter II.

## 2. Height Increment.

The study of the height-increment of large trees by any exact means is practically impossible; several forms of auxanometer have been used by Continental foresters, but these are both unsatisfactory and expensive. The height-increment of small trees up to 30 feet, and of saplings and seedlings has been studied by means of ordinary direct measurement with light rods and rules, over 10,000 individuals being kept under observation in various portions of the Knysna region. The data available, however, are not considered sufficiently definite to warrant publication at this stage.

The examples given in *Tables XLI* and *XLVI* of low rate of height-increment exhibited by seedlings growing under dense canopy are of interest. The plants described in *Table XLI* were situated on a northern aspect, in a medium-moist Forest rich in *Podocarpus Thunbergii*, *Olea laurifolia* and layer of *Trichocladus crinitus*, those described in *Table XLVI* occurred on the southern aspect of the same hill, in moist Forest, and under cover of dense layers of *Hemitelia capensis*.

## Table XLIII.

SUMMARY.—AVERAGE MEAN ANNUAL GIRTH INCREMENT PER 6-IN. GIRTH CLASSES: *PODOCARPUS THUNBERGII* HOOK.

Girth Class.	Exploited Forest.		Exploited and Tended Forest.		Natural Forest.	
	No. of Trees.	Av. M.A.G.I.	No. of Trees.	Av. M.A.G.I.	No. of Trees.	Av. M.A.G.I.
		Inches.		Inches.		Inches.
3-6.....	155	·093	17	·204	124	·067
7-12.....	157	·142	38	·187	130	·096
13-18.....	97	·188	37	·189	69	·118
19-24.....	87	·183	35	·321	55	·139
25-30.....	90	·202	30	·291	53	·141
31-36.....	72	·100	17	·241	29	·162
37-42.....	59	·223	8	·149	40	·143
43-48.....	38	·239	18	·259	23	·131
49-54.....	18	·284	5	·416	14	·240
55-60.....	10	·191	—	—	5	·162
61-66.....	2	·146	—	—	4	·222
67-72.....	1	·220	—	—	2	·131
73-78.....	1	·139	—	—	3	·168
79-84.....	—	—	—	—	1	·079
85-90.....	—	—	—	—	1	·098
Sums.....	787	—	205	—	553	—
Means.....	—	·187	—	·250	—	·139

\* Average mean annual Girth increment.

Table XLIII.—(Continued).

## PODOCARPUS ELONGATA, L'HERIT.

Girth Class,	Exploited Forest,		Exploited and Tended Forest,		Natural Forest,	
	No. of Trees,	Av. M.A.G.I.	No. of Trees,	Av. M.A.G.I.	No. of Trees,	Av. M.A.G.I.
Inches,						
3-6.....	7	·128	—	—	—	—
7-12.....	4	·209	1	·174	6	·116
13-18.....	4	·368	1	·100	1	·042
19-24.....	4	·319	1	·225	—	—
25-30.....	4	·316	—	—	4	·317
31-36.....	2	·341	1	·037	4	·142
37-42.....	1	·750	—	—	2	·268
43-48.....	2	·531	1	·137	1	·196
49-54.....	2	·343	1	·187	1	·406
55-60.....	2	·290	1	·268	2	·093
61-66.....	—	—	—	—	1	·178
67-72.....	1	·299	1	·012	1	·197
73-78.....	—	—	—	—	—	—
79-84.....	—	—	—	—	—	—
85-90.....	—	—	—	—	—	—
Sums.....	33	—	8	—	23	—
Means.....	—	·354	—	·148	—	·195

Table XLIII.—(Continued).

## OLEA LAURIFOLIA.

Girth Class,	Exploited Forest,		Exploited and Tended Forest,		Natural Forest,	
	No. of Trees,	Av. M.A.G.I.	No. of Trees,	Av. M.A.G.I.	No. of Trees,	Av. M.A.G.I.
3-6.....	198	·091	10	·283	139	·076
7-12.....	267	·125	25	·247	198	·097
13-18.....	160	·196	19	·347	136	·158
19-24.....	106	·264	18	·361	65	·214
25-30.....	69	·290	22	·371	46	·204
31-36.....	63	·318	11	·539	34	·220
37-42.....	43	·272	8	·371	23	·214
43-48.....	13	·297	2	·287	18	·211
49-54.....	25	·362	4	·352	10	·253
55-60.....	7	·474	—	—	2	·256
61-66.....	2	·187	—	—	—	—
67-72.....	2	·187	—	—	—	—
73-78.....	—	—	—	—	—	—
Sums.....	955	—	119	—	671	—
Means.....	—	·255	—	·350	—	·189

## OLEA CAPENSIS.

3-6.....	83	·072	—	—	61	·057
7-12.....	108	·151	—	—	95	·079
13-18.....	36	·152	—	—	36	·099
19-24.....	12	·167	—	—	9	·099
25-30.....	2	·156	—	—	3	·147
31-36.....	1	·125	—	—	—	—
Sums.....	242	—	—	—	204	—
Means.....	—	·137	—	—	—	·096

Table XLIII.—(Continued).

## APODYTES DIMIDIATA.

Girth Class.	Exploited Forest.		Exploited and Tended Forest.		Natural Forest.	
	No. of Trees.	Av. M.A.G.I.	No. of Trees.	Av. M.A.G.I.	No. of Trees.	Av. M.A.G.I.
Inches.						
3-6.....	157	·097	6	·263	175	·053
7-12.....	135	·133	14	·347	171	·111
13-18.....	63	·197	12	·324	89	·159
19-24.....	43	·198	5	·420	55	·174
25-30.....	21	·211	14	·299	34	·158
31-36.....	16	·255	3	·218	22	·155
37-42.....	11	·253	—	—	8	·137
43-48.....	5	·226	1	·325	1	·100
49-54.....	2	·250	—	—	—	—
55-60.....	—	—	—	—	—	—
61-66.....	1	·187	—	—	—	—
Sums.....	454	—	55	—	555	—
Means.....	—	·200	—	·313	—	·130

Table XLIII.—(Continued).

## OCOTEA BULLATA.

Girth Class.	Exploited Forest.		Exploited and Tended Forest.		Natural Forest.	
	No. of Trees.	Av. M.A.G.I.	No. of Trees.	Av. M.A.G.I.	No. of Trees.	Av. M.A.G.I.
Inches.						
3-6.....	132	·069	15	·227	—	—
7-12.....	64	·179	6	·243	66	·049
13-18.....	32	·216	6	·615	37	·223
19-24.....	31	·205	2	·487	14	·149
25-30.....	14	·243	2	·656	9	·081
31-36.....	13	·188	—	—	6	·122
37-42.....	6	·338	2	·506	3	·121
43-48.....	8	·181	2	·362	4	·176
49-54.....	—	—	—	—	4	·151
Sums.....	300	—	35	—	143	—
Means.....	—	·202	—	·402	—	·134

## CURTISIA FAGINEA.

3-6.....	123	·116	7	·203	89	·076
7-12.....	103	·164	9	·283	73	·133
13-18.....	40	·201	3	·190	34	·199
19-24.....	35	·161	4	·347	17	·216
25-30.....	22	·253	7	·276	11	·225
31-36.....	9	·253	3	·412	7	·183
37-42.....	3	·267	—	—	8	·158
43-48.....	1	·220	—	—	2	·098
49-54.....	—	—	—	—	1	·087
55-60.....	—	—	—	—	1	·125
Sums.....	336	—	33	—	243	—
Means.....	—	·217	—	·285	—	·150



Table XLIII.—(Continued).

## PLATYLOPHUS TRIFOLIATUS.

Girth Class.	Exploited Forest.		Exploited and Tended Forest.		Natural Forest.	
	No. of Trees.	Av. M.A.G.I.	No. of Trees.	Av. M.A.G.I.	No. of Trees.	Av. M.A.G.I.
Inches.						
3-6.....	21	·180	—	—	5	·130
7-12.....	33	·163	—	—	20	·141
13-18.....	19	·219	—	—	5	·257
19-24.....	16	·191	—	—	6	·333
25-30.....	7	·315	—	—	2	·171
31-36.....	1	·108	—	—	2	·371
37-42.....	3	·119	—	—	2	·572
43-48.....	1	·423	—	—	—	—
Sums.....	101	—	—	—	42	—
Means.....	—	·214	—	—	—	·282

## CUNONIA CAPENSIS.

3-6.....	—	—	—	—	4	·086
7-12.....	—	—	—	—	1	·187
13-18.....	—	—	—	—	4	·265
19-24.....	—	—	—	—	2	·096
25-30.....	—	—	—	—	1	·206
31-36.....	—	—	—	—	1	·275
37-42.....	—	—	—	—	—	—
43-48.....	—	—	—	—	1	·587
Sums.....	—	—	—	—	14	—
Means.....	—	—	—	—	—	·243

Table XLIII.—(Continued).

## GONIOMA, KAMASSI.

Girth Class.	Exploited Forest.		Exploited and Tended Forest.		Natural Forest.	
	No. of Trees.	Av. M.A.G.I.	No. of Trees.	Av. M.A.G.I.	No. of Trees.	Av. M.A.G.I.
Inches.						
3-6.....	259	·093	—	—	231	·057
7-12.....	301	·098	—	—	206	·070
13-18.....	111	·078	—	—	102	·061
19-24.....	23	·063	—	—	23	·065
25-30.....	10	·120	—	—	6	·032
31-36.....	—	—	—	—	—	—
Sums.....	704	—	—	—	568	—
Means.....	—	·090	—	—	—	·057

## PTEROCELASTRUS VARIABILIS.

3-6.....	177	·171	—	—	192	·119
7-12.....	191	·230	—	—	181	·180
13-18.....	61	·304	—	—	65	·236
19-24.....	37	·352	—	—	34	·247
25-30.....	25	·395	—	—	17	·255
31-36.....	11	·347	—	—	9	·312
37-42.....	8	·380	—	—	10	·342
43-48.....	1	·368	—	—	6	·163
49-54.....	1	·343	—	—	1	·037
55-60.....	—	—	—	—	1	·475
61-66.....	—	—	—	—	1	·231
Sums.....	512	—	—	—	517	—
Means.....	—	·321	—	—	—	·236

Table XLIII.—(Continued).

## ELAEODENDRON SPP. (CROCEUM AND CAPENSE).

Girth Class.	Exploited Forest.		Exploited and Tended Forest.		Natural Forest.	
	No. of Trees.	Av. M.A.G.I.	No. of Trees.	Av. M.A.G.I.	No. of Trees.	Av. M.A.G.I.
Inches.						
3-6.....	158	·083	6	·181	143	·061
7-12.....	111	·115	18	·244	95	·084
13-18.....	21	·150	5	·112	19	·135
19-24.....	3	·049	1	·086	7	·081
25-30.....	5	·089	1	·074	3	·182
31-36.....	5	·091	—	—	1	·236
37-42.....	—	—	—	—	—	—
43-48.....	—	—	—	—	1	·131
49-54.....	—	—	—	—	2	·105
Sums.....	303	—	31	—	271	—
Means.....	—	·096	—	·139	—	·126

## CELASTRUS ACUMINATUS.

3-6.....	39	·120	—	—	25	·083
7-12.....	41	·146	—	—	23	·098
13-18.....	17	·171	—	—	14	·116
19-24.....	19	·234	—	—	5	·096
25-30.....	1	·312	—	—	1	·062
31-36.....	2	·156	—	—	—	—
Sums.....	119	—	—	—	68	—
Means.....	—	·189	—	—	—	·091

Table XLIII.—(Continued).

## CELASTRUS PEDUNCULARIS.

Girth Class.	Exploited Forest.		Exploited and Tended Forest.		Natural Forest.	
	No. of Trees.	Av. M.A.T.I.	No. of Trees.	Av. M.A.G.I.	No. of Trees.	Av. M.A.G.I.
Inches.						
3-6.....	47	·100	—	—	26	·060
7-12.....	40	·108	—	—	46	·101
13-18.....	19	·191	—	—	15	·110
19-24.....	5	·218	—	—	5	·184
25-30.....	1	·218	—	—	2	·243
31-36.....	—	—	—	—	1	·427
37-42.....	1	·168	—	—	—	—
Sums.....	113	—	—	—	95	—
Means.....	—	·167	—	—	—	·187

## MYRSINE MELANOPHLEOS.

3-6.....	4	·080	—	—	7	·098
7-12.....	4	·137	—	—	8	·311
13-18.....	3	·333	—	—	12	·231
19-24.....	2	·361	—	—	11	·217
25-30.....	1	·215	—	—	7	·300
31-36.....	—	—	—	—	5	·172
37-42.....	—	—	—	—	5	·229
43-48.....	—	—	—	—	4	·189
49-54.....	—	—	—	—	1	·145
Sums.....	14	—	—	—	60	—
Means.....	—	·225	—	—	—	·210

Table XLIII.—(Continued).

## ILEX (CAPENSIS) MITIS.

Girth Class.	Exploited Forest.		Exploited and Tended Forest.		Natural Forest.	
	No. of Trees.	Av. M.A.G.I.	No. of Trees.	Av. M.A.G.I.	No. of Trees.	Av. M.A.G.I.
Inches.						
3-6.....	35	·032	—	—	15	·123
7-12.....	46	·298	—	—	32	·180
13-18.....	36	·291	—	—	13	·233
19-24.....	8	·333	—	—	10	·360
25-30.....	1	·306	—	—	7	·562
31-36.....	—	—	—	—	5	·375
37-42.....	—	—	—	—	1	·193
43-48.....	—	—	—	—	1	·400
49-54.....	—	—	—	—	—	—
Sums.....	126	—	—	—	84	—
Means.....	—	·292	—	—	—	·279

## OCHNA ARBorea.

Girth Class.	Exploited Forest.		Exploited and Tended Forest.		Natural Forest.	
	No. of Trees.	Av. M.A.G.I.	No. of Trees.	Av. M.A.G.I.	No. of Trees.	Av. M.A.G.I.
3-6.....	24	·034	—	—	22	·032
7-12.....	24	·040	—	—	14	·041
13-18.....	2	·034	—	—	8	·035
19-24.....	—	—	—	—	3	·037
Sums.....	50	—	—	—	47	—
Means.....	—	·036	—	—	—	·036

Table XLIII.—(Continued).

## OLINIA CYMOSA.

Girth Class.	Exploited Forest.		Exploited and Tended Forest.		Natural Forest.	
	No. of Trees.	Av. M.A.G.I.	No. of Trees.	Av. M.A.G.I.	No. of Trees.	Av. M.A.G.I.
Inches.						
3-6.....	12	·082	—	—	—	—
7-12.....	17	·234	—	—	4	·646
13-18.....	7	·391	—	—	—	—
19-24.....	6	·547	—	—	1	·606
25-30.....	3	·682	—	—	—	—
31-36.....	1	·787	—	—	—	—
37-42.....	1	·731	—	—	—	—
43-48.....	1	·493	—	—	—	—
49-54.....	3	·569	—	—	—	—
55-60.....	2	·444	—	—	—	—
Sums.....	53	—	—	—	5	—
Means.....	—	·496	—	—	—	·626

## KIGGELARIA AFRICANA.

Girth Class.	Exploited Forest.		Exploited and Tended Forest.		Natural Forest.	
	No. of Trees.	Av. M.A.G.I.	No. of Trees.	Av. M.A.G.I.	No. of Trees.	Av. M.A.G.I.
3-6.....	6	·244	—	—	—	—
7-12.....	2	·303	—	—	—	—
13-18.....	1	·293	—	—	1	·131
Sums.....	9	—	—	—	1	—
Means.....	—	·280	—	—	—	·131

Table XLIV.

ANNUAL GIRTH INCREMENTS SHOWN BY THE 16 MAIN SPECIES OCCURRING ON  
2 ACRES OF FOREST (MEDIUM HOLLARD), SOURFLATS.

Girth Classes	Number of Trees Studied.	Species.	Period of Observation.	Girth Increment per Individual.
Inches.				Inches.
0-6	6	Podocarpus Thunbergii, Hook.....	1924-5	·0729.
7-12	10		"	·1437
13-18	8		"	·1797
19-24	6		"	·2916
25-30	5		"	·1875
31-36	1		"	·3125
37-42	2		"	·1562
43-48	6		"	·2604
49-54	1		"	·1250
0-7	1	Podocarpus elongata, L'Herit.....	1924-5	·1250
0-6	10	Olea laurifolia.....	1924-5	·0500
7-12	9		"	·1666
13-18	9		"	·2430
19-24	7		"	·2500
25-30	6		"	·1979
31-36	2		"	·3437
37-42	1		"	·1250
55-60	1		"	·1875
0-6	7	Apodytes dimidiata.....	1924-5	·1160
7-12	23		"	·1875
13-18	19		"	·2368
19-24	10		"	·3687
25-30	4		"	·4531
31-36	2		"	·2812
37-42	1		"	·1250
0-6	4	Ocotea bullata.....	1924-5	·0781
13-18	8		"	·1797
19-24	6		"	·2395
25-30	2		"	·2500
37-42	1		"	·1875
43-48	2		"	·2500
0-6	3	Curtisia faginea.....	1924-5	·1250
7-12	3		"	·1458
13-18	2		"	·3437
19-24	5		"	·4000
13-18	1	Platylophus trifoliatus.....	1924-25	·2500
25-30	1		"	·3125
37-42	1		"	·9375
49-54	1		"	·5625
7-12	1	Cunonia capensis.....	1924-5	·1250
19-24	2		"	·1875
37-42	1		"	·1250
55-60	1		"	·6250
0-6	2	Gonioma Kamassi.....	1924-5	·0625
7-12	9		"	·1388
13-18	6		"	·1458
0-6	2	Pterocelastrus variabilis.....	1924-5	·1875
7-12	22		"	·0909
13-18	12		"	·1666
19-24	14		"	·1428
25-30	5		"	·1500
31-36	5		"	·1799
37-42	7		"	·3750
37-42	1		"	·3750
0-6	2	Elaeodendron croceum and capense....	1924-5	·0312
13-18	2		"	·1562
19-24	1		"	·0625
7-12	3	Celastrus acuminatus.....	1924-5	·1458
13-18	5		"	·1625
19-24	1		"	·1250
7-12	2	Celastrus peduncularis.....	1924-5	·0937
7-12	2	Ilex (capensis) mitis.....	1924-5	·0937
13-18	5		"	·2125
13-18	3	Olinia cymosa.....	1924-5	·4375
31-36	1	Nuxia floribunda.....	1924-5	·2500

Table XLV.

EXAMPLE OF HEIGHT-INCREMENTS OF SEEDLINGS IN FOREST, RICH IN TRICHOCLADUS CRINITUS LAYERS: AVERAGE HOLARD = 45% DRY WEIGHT.

Species.	Heights.		Species.	Heights.	
	25/5/25.	23/6/26.		25/5/25.	23/6/26.
Podocarpus Thunbergii Hook...	Ins.	Ins.	Podocarpus Thunbergii Hook.. (contd.)	Ins.	Ins.
	9	9		18	21½
	7½	8		53	53
	6	7½		30½	33½
	49	49		55½	56½
	11	11½		100½	102½
	10½	11½		10	12
	7½	8		32	43½
	10½	11		61½	63½
	11	11½		44½	47
	22½	24		39	46½
	24½	26½		44½	45
	16½	16½		52	67
	24½	28½		96	99
	6½	6½		28	32
	7½	8			
	25	25½	Podocarpus elongata, L'Herit...	39	39
	9	9½		100	100
	8½	8½		12	12
	30½	31			
	14	14½	Olea laurifolia.....	7½	7½
	13½	31½		20½	20½
	20	21½		36	39½
	9½	10		10	12½
	9	9½			
	9½	9½	Ocotea Bullata.....	26½	26½
	38	46		15½	15½
	20½	21		21	28½
	17	17½		54	54½
	27	27		50	53½
	33½	34½		17½	18½
	5	5½		18	20½
	13½	13½		20½	20½
	53½	53½		41	44½
	19	19		7½	7½
	22	22½	Apodytes dimidiata.....	5½	5½
	12	12½			
	23	27½	Elaeodendron croceum.....	16	19½
	31	36½		31	34
	26	29½		6½	8
	48½	53			
	49	52			
	50	58			

Table XLVI.

EXAMPLE OF HEIGHT-INCREMENTS OF SEEDLINGS IN FOREST, RICH IN HEMITELIA CAPENSIS LAYERS: AVERAGE HOLARD 170% DRY WEIGHT.

Species.	Heights.		Species.	Heights.	
	25/5/25.	21/6/26.		25/5/25.	21/6/26.
Podocarpus Thunbergii Hook...	Ins.	Ins.	Ocotea bullata.....	Ins.	Ins.
	5	5		8½	9½
	9	9½		4½	5½
	7	7		11½	12½
	4	4		5	5
	7	7		6	7
	5	5½		6	6½
				20½	21
Podocarpus elongata, L'Herit...	6	6		7½	8
Olea laurifolia.....	6½	9½		13	13½
				8	8½
Curtisia faginea.....	4	4½		7½	8
	4½	4½		16½	17½
				17½	18
Apodytes dimidiata.....	4	6		25	26
	2½	2½		5½	5½
Canonia capensis.....	5½	6½			
	30	31			

## Chapter X.

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THE FORMER EXTENT OF THE FORESTS  
and  
THE RESULTS OF DISTURBANCE.



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## THE FORMER EXTENT OF THE FORESTS AND THE RESULTS OF DISTURBANCE.

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### (a) THE FORMER EXTENT OF THE FORESTS.

A. F. W. Schimper's statement (*vide* R. Marloth: 1908: 207) concerning the interesting subject whether the Forests ever had been much more extensive than they are under present-day conditions, has already been referred to in Chapter III (p. 100)—it remains to state reasons why the writer is of the opinion that while the Forests were much more extensive in past centuries, it is unlikely that the whole area between the ocean and the upper mountain slopes ever bore Forests.

Schimper (*loc. cit.*) considers that areas of primitive *Macchia* existed near the Forests, and that these were increased by man at the expense of the adjacent Forests. Since 1922 very careful and fairly extensive study of much of the *Macchia*-clad ground near and far removed from the Forests has been made, numerous examinations of soil strata and of vegetation relicts therein being carried out. The results obtained are summarized below:—

- (1) Areas of *Macchia* exist that show no sign of relicts of Forest nature in the soil strata. Such areas bear a shorter, less luxuriant type of *Macchia* (even where protected from fire, grazing, and other disturbance) than do the areas described below. This *Macchia* type appears to be climax in nature—it is the highest expression of the capacity of the habitat, and has not at any time been Forest. Upper mountain slopes, the whole of the summits of the range, portions of the foothills and certain limited lateritic portions of the plateaux fall into this type. So far as the production of exotic tree plantations is concerned, this type of *Macchia* is likely to produce less favourable results than the types described below.
- (2) Extensive areas of *Macchia* exist, from the soil of which large numbers of Forest relicts have been taken, in the form of ancient, and often charred, roots and stems, and charred resinous matter.

Microscopic examination of these woody relicts has shown them to be of such species as compose the Forest to-day; particularly common are *Ocotea bullata*, *Platylopus trifolius*, and *Olea lanrifolia*, probably on account of their excellent decay-resisting powers. The charred resinous matter apparently is of the same nature as the substances formed by *Myrsine* and *Pterocelastrus*. In addition to wood and resinous matter there are well defined, incinerated layers in the soil, at depths of from 12 to 18 inches; too deep to be the results of fire in the *Macchia*. The *Macchia* on the ground, wherever protected, grows tall, and shows the presence of Scrub, Bush, and Forest forms. The manner in which the areas of this type connect



innumerable Forest patches (*vide* vegetation maps of the region) certainly supports the hypothesis that the Forests covered them in time past.

Judging from the appearance of most of the relicts and from the depth of these below the surface, the Forests to which they relate, must have disappeared from the ground many centuries before the European ever set foot in the region. Naturally some of the relicts belong to Forests that occupied the soil less than a century ago.

- (3) Actual relict trees or small relict communities occur at distances of several miles from the Forests, in places where they receive protection from fire and other agencies of disturbance. The soil strata of the areas of Macchia linking up such relict patches, invariably show the presence of wood relicts.

Were it possible to preserve strictly the Macchia (and the scattered Scrub and Bush relicts mingled with the latter) occurring on areas akin to types (2) and (3) described above, steady re-afforestation would take place by process of succession.

The subtropical element in the region is evidently the assertive one, the temperate or south-western the retreating. The subtropical flora has progressed to the utmost south-western limit of the Cape Province, and in centuries past—if we are to believe the records of the old Dutch settlers and the present-day testimony of the vegetation itself—a Forest belt with but minor interruptions, extended from near the town of George to the Cape.

Owing to man's interference (*vide* Chapter III, Section on History of the Forests, pp. 99-104), the Forests have been considerably diminished, but if one views the possibilities broadly, one cannot fail to be impressed with the thought that granted protection, the Forests—and therefore the subtropical flora—would commence their work of recapturing much territory lost to them in ages past. The Forests are blessed with vast potential in the direction of extension of their bounds, and their flora in the production of new forms possesses great possibilities. There is very slender evidence that the climate of the region has changed materially in any of the efficient factors within the period separating the present from the Tertiary, or if need be, from the Cretaceous; accordingly there is no reason for suspecting that the Forests are out of equilibrium with their environment, and are *naturally* retreating.

#### (b) *The Results of Disturbance.*

The principal agencies of Forest disturbance are fire, exploitation, and grazing.

##### 1. *Fire.*

The results of fire so far as diminution of area is concerned, have already been discussed, but it is necessary to touch upon the successional features following disturbance by that agency.

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\* For further details regarding the influences of fire upon Macchia and Forest, *vide* Phillips, 1930; (2).

Forest fires rarely originate within the Forests, but attack from the margins where the flames find ready fuel in the *Macchia* shrubs and debris. Two distinct types of fire are common, the *ground fire* and the *crown fire*.

(i) *The ground fire*.—The ground fire burns into the leaf litter, humus layer, and root-mass layer, and usually remains alive several weeks in dry weather, despite combat by man. The roots of the less deeply rooted species are generally severely burned, the trees dying several weeks after. All germules except those of more deeply buried *Virgilia capensis*, and all regeneration, are destroyed.

The roots and lowest portions of the boles of the deeper rooted species (*vide* p. 221, Chapter IX) often escape death, but lose their upper boles; they frequently coppice from the burnt stumps several months after the fire. Notable in this respect are *Ocotea*, *Curtisia*, *Elaeodendron croceum*.

The succession following such a ground fire usually is much as follows:—\*

- (1) Dense weed growth, principally *Helichrysum petiolatum*, *H. foetidum*, *H. diffusum*, *H. parviflorum*, *H. felinum*, *Hippia frutescens*, *Bidens pilosa*, *Senecio glastifolius*, *S. umbellatus*, *S. nudifolium*, *Dicrocephala latifolia*, *Leontonyx squarrosa*, *Asclepias fruticosa* (in extensive consocieties), *Solanum nigrum*, *Physalis pubescens*, *Rubus pinnatus*, *R. fruticosus*, *R. rigidus* (the 3 species forming dense tangles), *Plectranthus* spp., *Hypoestes verticillata* (drier portions), *Tetraria* spp., *Schoenoxiphium* spp., *Ficinia* spp., seedlings of *Cluytia* spp., and other shrubs mentioned in (2) below, appear, and the stumps of trees commence to produce coppice.

The plants above recorded occur either in consocieties or associates.

- (2) A number of weak, woody shrubs appear, in consocieties or associates; these build up a canopy 8 to 15 feet in height. The principal species of this stage are *Psoralea* spp. (especially *P. pinnata*, *P. axillaris*); *Podalyria* spp. (especially *P. calyptata*, *P. cuneifolia*); *Crotalaria* spp.,† *Cluytia* spp. (especially *C. affinis* and *C. pulchella*); *Andrachne ovalis*, *Rhamnus prinoides*, *Polygala myrtifolia*, *P.* spp., *Erica canaliculata*, *E. speciosa*, *Berzelia intermedia*, *Brunia nodiflora*, *Metalasia muricata*, *Osteospermum moniliferum*, *C. corymbosum*, *Phyllica* spp., *Sparmannia africana*.‡ The rate of growth is fast, within 18 months the cover may be up to 10 feet in height.

Seedlings of *Halleria lucida* and *Burchellia capensis* may be present at this time but do not grow at the same rates as the other spp., if *Virgilia capensis* seedlings occur in stage (1), they will have formed a canopy over 10 feet high within 18 months.

- (3) *Virgilia capensis* builds up a community with a general height of 20 to 30 feet; under cover of the *Virgilia* occur numerous seedlings, saplings and poles of *Halleria lucida*,

\* *Vide* Schematic Chart: Diagram XXVII.

† Especially *Crotalaria purpurea*.

‡ *Passerina falcifolia*.

*Burchellia capensis*, *Royena lucida*, *Olea capensis*, *O. foveolata*, *Plectronia Mundtii*, *P. obovata*, *P. ventosa*, *Myrsine melanophlebos*, *Kiggelaria africana*, *Ekebergia capensis*, and often local patches of regeneration of *Ocotea*, *Apodytes*, *Podocarpus* spp. A certain number of relicts of stage (2) remains on opener portions of the area.

- (4) The *Virgilia* gradually decays and disappears (10 to 25 years) after the fire, leaving the *Halleria*, *Burchellia*, *Royena lucida*, and other species mentioned above, to form such consociates and associates as they can. In this manner is Forest reconstructed.

(ii) *The crown fire*.—The crown fire does practically no harm to the soil, to the young trees, or to the roots of the dominants, the fire being confined to the canopy formed by the larger, drier trees. The fire leaps from crown to crown, producing stagheaded trees that may remain alive for many years, but never reproduce normal crowns. Such injured, dry topped individuals serve as tempting bait for the next holocaust.

Crown fires naturally are often associated with ground fires, for the falling arms may ignite the litter on the floor and thus produce a ground fire.

Where the canopy is much opened up through the destruction of the crowns of trees adjacent, the lower layers of the Forest are generally damaged or destroyed by the falling debris, and a subseral succession of the type described for the ground fire above, may be originated. On the other hand, if slight disturbance of the lower Forest layers be caused, no subseral succession is originated, the young trees forming the layers merely developing to take the place of the older ones damaged or destroyed.

*Gleichenia polypodioides* consociates on burnt sites.

An important community that takes possession of burnt Forest no matter what the nature of the fire, is the *Gleichenia polypodioides* consociates.

*Gleichenia* enters the burnt area together with the usual weedy flowering plants, but readily suppresses these within several months. Its rich, branching, extensive fronds creep for many yards, and wherever they obtain the least support, commence to climb upward. In a short time the entire area is covered with the fronds. In August-October of each year, fresh strata of fronds are produced, the older fronds remaining alive for several years, but finally drying; on drying they do not fall but remain in position. The wire-like stems remain alive for many years. In the course of from five to twenty years a dense mass of rhizome, stem, and frond is built up, this mass ranging from 6 to over 12 feet in depth. The portions composed of the first few years' fronds are gradually compacted into an impenetrable mat through the weight of the vegetation above. This mat in time becomes from 6 to 12 inches in thickness, and is constantly increased in thickness through the reaction of the fern. No other species of plants can establish themselves in the consociates, for the seeds cannot reach the soil proper, and even were they to do so, they would be unable to establish plants in the dark and humid mass of vegetation.

The consociates is capable of holding the ground for many years—examples are known to the writer where areas destroyed by fire 30 to 70 years ago, still are held by most luxuriant communities of the fern, showing no signs of allowing invaders to enter the territory.

The fern is not only defensive of its territory but actually also offensive—small trees or large shrubs growing along the margins of the communities of *Gleichenia*, are within a few years be-decked with a picturesque drapery of fronds causing death of the foliage and ultimately disappearance of the trees or shrubs. Even trees of 20-30 feet in height are scaled, and either killed or much impaired by the engulfing wealth of fronds. Should it happen, however, that there be a few members or coppicing species on the area that has been burned, and should these be of vigorous growth, the fern is finally shaded and in this manner ousted. The quick-growing shoots of *Ocotea*, *Olinia*, *Platylophus*, *Gonioma*, and *Halleria*, within a few months of the fire are several feet above the level of the fern. For some years the shade cast by these shoots is insufficient to react detrimentally upon the fern, but when these shoots have formed a canopy cutting down the light-intensity to 1/10-1/20 of full sunlight, the fern immediately commences to show lack of vigour: increased density of the canopy results in gradual death of the *Gleichenia*.

The writer has studied methods of destroying the ground-wasting fern. To the present the most satisfactory and economical method known is to slash down the fern, but to leave quite undisturbed the 6-12 inch mat of rhizome, then to dig small holes in this mat about 3 by 3 feet apart, in which holes seedlings of the fast-growing, insolation-hardy *Virgilia* are planted. Disturbance of the rhizome mat to any extent results in the appearance of rank weed growth.

Once slashed down, the fern rarely attempts to recapture lost ground.\*

The community has been described by J. F. Phillips [1926 (3)] in connection with the dormancy of seeds of *Virgilia capensis*.

## 2. *Exploitation.*

The subject of the history of exploitation of the Forests has already been discussed (*vide* Chapter III, pp. 102-104), and it remains only to describe briefly the successional influences of this form of disturbance.

Exploitation has been responsible for the removal of varying degrees of the upper canopy and of the lower canopies. In most Forest owned privately the degree of removal has been very severe, the Forests under Forest Department control having received much better treatment.

The consequence of removal of the canopy to any appreciable extent has been the introduction of insolation factors detrimental to both aerial and edaphic factors of the Forest. Regeneration of the Forest trees and of the large woody shrubs, while fully capable of reconstructing the Forest on all sides of reasonable dimensions is either unable to do so, or finds great difficulty in doing so, on sites of more than 40 yards in diameter. Regeneration appearing on isolated sites soon after removal of the cover is lesioned, as described in Chapter II (pp. 39-96). Regeneration appearing after the weed

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\* December, 1930: Areas cleared in 1923 remain fern-free.

communities have captured the sites is unable to develop, owing to the severe competition of these communities for moisture and room. Seeds reaching the sites after they have been captured by the weeds, are often unable to germinate owing to the absence of suitable moisture conditions; moreover many of them fail to reach the soil surface owing to the dense weed masses. Such seeds as do germinate under cover of the weeds fail to produce healthy seedlings, owing to the unfavourable light, humidity, and aeration factors. The weed communities, it is scarcely necessary to point out, are the direct results of allowing insolation factors to work upon the Forest floor.

The principal succession stages in exploited Forest are as follows:—

- (1) Dense weed growth on heavily exploited sites principally *Helichrysum petiolatum* (which forms dense masses many yards in extent and from 2 to 10 feet in height, these masses pressing heavily upon the soil and cutting down the light-intensity to 1/300 to 1/600 that of full sunlight, at ground level, and removing much moisture from the upper soil layers); *Helichrysum foetidum* (which forms tall-growing, upright consocieties many yards in extent); *Bideas pilosa* (which forms dense, usually upright consocieties covering many yards); *Hippia frutescens* (forming semi-prostrate, dense, untidy consocieties of considerable extent), *Senecio glastifolius* (forming upright, untidy consocieties of very considerable density); *Rubus fruticosus* (introduced to the region in the early nineteenth century, now a troublesome weed); *R. rigidus* (forming extensive, impenetrable consocieties); *R. pinnatus* (forming small consocieties of moderate density); *Cliffortia odorata* (forming extensive consocieties of great density); *C. ferruginea*; *Polygonum sengalense* (exotic—forming dense consocieties in some Forests); *Plectranthus fruticosus* (forming very large consocieties sometimes of great density, cutting down the light-intensity as low as 1/500); *Verbena bonariensis* (frequently in dense consocieties); *Cluytia pulchella*, *C. affinis*, *C. alaternoides* (in seeding stages—in consocieties and associates of great density, completely covering the ground); *Physalis pubescens* (in untidy consocieties, sometimes dense); *Solanum nigrum* (very dense, untidy, semi-prostrate consocieties); *S. giganteum* (forming tall, upright consocieties which cut down the light-intensity greatly when they are dense); various *Cyperaceae* (chiefly *Schoenoxiphium lanceum*, *Tetraria* sp. nov.; *Picinia sylvatica*, *Picinia capillifolia*, *Scirpus tenellus* (very moist paths); *S. prolifer* (moist sites generally) *Mariscus congestus* (forming extensive consocieties where soil is damp); *Carex aethiopica* (scattered throughout moist exploited sites); *Juncus lomatophyllus* (on damp sites only); *Zantedeschia aethiopica* (forming extensive and dense consocieties where moist conditions prevail).
- (2) Shoots of *Halleria lucida*, *Royena lucida*, *Platylophus trifoliatus*, *Cunonia capensis*, *Gonioma Kamassi* appear wherever trees of these spp. have been felled, the shoots

within several years attaining heights ranging from 6 to 18 feet, and casting a fair degree of shade. Mingled with these shoots are the following weak, woody shrubs, forming a canopy 8 to 12 feet in height within 18 months of exploitation:—*Osteospermum moniliferum* (principally in Forests nearer the coast); *Cluytia pulchella* (an important shrub of wide distribution); *C. affinis*; *Adenocline mercurialis*; *Cassia tomentosa* and *C. occidentalis* (large shrubs or small trees of fast growth, possibly exotic); *Psoralea pinnata* (forming very close consocieties); *Virgilia capensis* (scattered, except where local fires have scorched the soil); *Podalyria* spp.; *Crotalaria* spp.; *Polygala myrtifolia* (forming tall and extensive consocieties in some places); *P. oppositifolia* (forming short, dense consocieties or mixed with *P. myrtifolia*); *Rhamnus prinoides*; *Erica canaliculata* (local, but dense where it does occur); *Berzelia intermedia* (forming dense consocieties); *Metalasia muricata* (building very dense, tall consocieties reacting strongly on the light). *Passerina falcifolia* is locally abundant, forming consocieties to 10 feet in height.

- (3) The *Halleria* shoots, which are frequently abundant on exploited sites, within 5-15 years, according to locality and type of Forest, attain heights ranging from 15 to 25 feet in height, and form a canopy which protects the plants below it from insolation, but which does not cut down the light too strongly.

*Halleria* is often assisted in this work of reconstruction by shoots of *Royena lucida*, *Burchellia capensis*, *Platylophus*, *Ocotea*, *Curtisia*, *Gonioma*. Under canopy of the shoots, the weak woody shrubs commence to thin out, and seedlings of desired Forest species appear, and grow fast. Within the space of another 5 to 10 years, the exploited site shows presence of saplings of Forest trees growing under cover of the now relatively large *Halleria*, *Burchellia*, and *Gonioma* shoots, and under the much higher shoots of *Ocotea*, *Curtisia*, and *Platylophus*.

On slightly exploited sites the weeds of stage (1) afore described, are few and non-rampant, the shrubs of stage (2) acting as the real pioneers of the subsera, and building up the canopy within a few years.

The following Raunkiär analysis of the ground vegetation existing on a portion on practically *clear-felled* Forest 4 years after removal of the Forest canopy, gives an impression of the species found on such sites, and of their relative abundance.

## EXPERIMENTALLY CLEAR-FELLED FOREST, SOURFLATS.

Species Occurring. (No Plants over 15 Feet in Height Recorded.)	Number of 1-square metre circles on which they occurred, out of a possible 100.
<i>Plectranthus fruticosus</i> .....	58
<i>Halleria lucida</i> seedlings.....	56
<i>Cluytia pulchella</i> .....	38
<i>Trichocladus crinitus</i> shoots.....	34
<i>Galopina circaeoides</i> .....	26
<i>Helichrisum petiolatum</i> .....	26
<i>Carex aethiopica</i> .....	24
<i>Schoenoxiphium lanceum</i> .....	24
<i>Curtisia faginea</i> seedlings.....	20
<i>Pteridium aquilinum</i> .....	20
<i>Blechnum punctulatum</i> .....	20
<i>Burchellia capensis</i> seedlings.....	19
<i>Hemitelia capensis</i> shoots.....	16
<i>Cluytia affinis</i> .....	14
<i>Nuxia floribunda</i> seedlings.....	14
<i>Trichocladus crinitus</i> seedlings.....	14
<i>Moraea iridioides</i> .....	12
<i>Oxalis</i> sp. (no flowers).....	12
<i>Apodytes dimidiata</i> shoots.....	10
<i>Helichrysum parviflorum</i> .....	10
<i>Elaeodendron croceum</i> shoots.....	10
<i>Burchellia capensis</i> shoots.....	8
<i>Ocotea bullata</i> shoots.....	8
<i>Royena lucida</i> seedlings.....	6
<i>Halleria lucida</i> shoots.....	6
<i>Olea laurifolia</i> seedlings.....	6
<i>Cyperus tenuis</i> .....	6
<i>Helichrysum foetidum</i> .....	6
<i>Clematis Thunbergii</i> .....	6
<i>Erica canaliculata</i> .....	6
<i>Stoebe cinerea</i> .....	6
<i>Impatiens capensis</i> .....	5
<i>Cryptostemma calceolaceum</i> .....	4
<i>Asparagus</i> sp.....	4
<i>Platylophus trifolius</i> seedlings.....	4
<i>Aristea pusilla</i> .....	4
<i>Podocarpus Thunbergii</i> seedlings.....	4
<i>Plectronia Mündtli</i> seedlings.....	4
<i>Aacacia melanoxylon</i> seedlings (seeds introduced by birds).....	4
<i>Acacia melanoxylon</i> shoots.....	4
<i>Euryops virgineus</i> .....	2
<i>Rubus pinnatus</i> .....	2
<i>Rubus fruticosus</i> .....	2
<i>Ficinia capillifolia</i> .....	2
<i>Juncus capensis</i> .....	2
<i>Pellaea viridis</i> .....	2
<i>Rumex acetosella</i> (introduced by cattle).....	2
<i>Athanasia muricata</i> .....	2
<i>Serpicula (Laurembergia) repens</i> .....	2
<i>Pterocelastrus variabilis</i> shoots.....	2
<i>Celastrus acuminatus</i> seedlings.....	2
<i>Zelmeria scabra</i> .....	2
<i>Pyrenacantha scandens</i> .....	2
<i>Rhamnus prinoides</i> .....	2
<i>Gonionna Kamassi</i> shoots.....	2
<i>Wahlenbergia procumbens</i> .....	2
<i>Senecio</i> sp. (no flowers).....	2
<i>Trimeria alnifolia</i> seedlings.....	2
<i>Secamone Alpini</i> .....	2

A point of some importance with respect to exploitation of Forest is that the absence of natives from the region has preserved the seedlings and saplings from destruction. The Forests of the Eastern Province and of the Transkeian Territories, in most places, have been cleared of their young regeneration stages, the pliable saplings being used by the natives for hut-building purposes.

The subject of careful exploitation of Forest so that the state of the latter, so far from being depreciated, is actually improved, is discussed in Appendix 3.

Without entering into details concerning their structure, it is desirable to list the more important subseral communities that appear on exploited sites in various portions of the Forest:—

*In Consocies.*—

*Psoralea pinnata*.  
*Crotolaria purpurea*.  
*Virgilia capensis*.  
*Osteospermum moniliferum*.  
*Osteospermum corymbosum*.  
*Metalsia muricata*.  
*Polygala myrtifolia*.  
*Helichrysum petiolatum*.  
*Halleria lucida*.  
*Rhamnus prinoides*.  
*Emplenrum serrulatum*.  
*Barosma scoparia*.  
*Berzelia intermedia*.  
*Plectranthus fruticosus*.  
*Sparmannia africana*.  
*Cassinopsis capensis*.  
*Cluytia pulchella*.  
*C. affinis*.  
*Passerina falcifolia*.<sup>\*</sup>  
 Tangles of *Scutia (indica) Commersonii*, draping trees.  
 Tangles of *Rhoicissus capensis*, draping trees.  
 Tangles of *Mikania capensis*, draping trees.  
*Laurophyllus capensis (Botryceras laurinum)*.  
 The possibly exotic *Cassia tomentosa* and *C. occidentalis*.

*In Associes.*—

Two or more of the above species.  
 Particularly:—  
*Halleria lucida*—other spp.  
*Virgilia capensis*—other spp.  
*Cluytia pulchella*—*C. affinis*.  
*Laurophyllus*—other spp.  
*Osteospermum*—other spp.

3. *Grazing.*

Owing to the absence of a native poulation, the Knysna Forests have escaped to a very large extent the evils of grazing by cattle, sheep, goats. In certain areas oxen have destroyed much of the younger regeneration, but such sites if protected, speedily produce young plants from seeds "walked" into the soil by the cattle. Forest much frequented by cattle, however, gradually opens up so far as the lower layers are concerned, for regeneration stages are prevented from developing and the woody shrubs are gradually eliminated (*vide* plate 50.) The Forests of the Eastern Province, owing to the large degree of grazing to which they have been subjected for generations, assume in parts a non-active aspect almost entirely absent at the Knysna.

<sup>\*</sup> *P. filiformis* in forests at Karatara and Farleigh, west of Knysna.





# Appendix 1.

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## GENERAL BIOLOGY OF THE FLOWERS, FRUITS and YOUNG REGENERATION OF THE MORE IMPOR- TANT SPECIES OF THE KNYSNA FORESTS.\*

(A SUMMARY OF PRELIMINARY STUDIES.)

[*Vide* Phillips, 1926: (4).]

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\* 63 spp.



# GENERAL BIOLOGY OF THE FLOWERS, FRUITS, AND YOUNG REGENERATION OF THE MORE IMPORTANT SPECIES OF THE KNYSNA FORESTS.

(A SUMMARY OF PRELIMINARY STUDIES.)

[Vide Phillips, 1926: (4).]

## INTRODUCTORY REMARKS.

As practically no information concerning the biology of the flowers, fruits, and young regeneration of the more important South African forest trees and shrubs was available, the writer—under the direction of the Chief Conservator of Forests—in January, 1923, commenced collecting data relating to the subject. The principal objects of the investigation are the elucidation of the behaviour of the species with respect to seasons of flowering and fruiting, study of pollination phenomena, the collection of information regarding the nature, efficiency, dispersal, and germination of the seeds, and the study of the establishment and fate of young regeneration.

The aim of the present communication is to summarize the information at present available for about 63 species of trees and woody shrubs occurring at the Knysna. The nature of the communication precludes discussion of any but the salient features in the biology of the flowers, fruits, and regeneration of the various species.

## METHODS.

The methods employed are essentially simple: the *monthly observation* of over 2,000 selected trees of the various species, for the sake of collection of *phenological* data; the study of the *structure* of flowers and fruits; *pollination experiments in Nature and under control*; observations and experiments connected with *dispersal* of fruits and seeds; nursery and quadrat *germination* experiments.

### 1. Flowering and Fruiting Seasons.

As has been pointed out by the writer (1926 "1")\* in another paper, the phenomena exhibited by certain Knysna trees with respect to flowering and fruiting seasons are not readily explicable.—Some species are most irregular as to flowering and fruiting seasons: trees of the same or of different species may flower every month in one year and not on a single occasion in the next; they may flower profusely at certain periods in one year, poorly at identical periods in the next, and not at all at the same time in the year following; there may be intervals of one year or of two, three, or more years between flowering periods—endless variation in behaviour is exhibited. Owing to the absence of a definite dry season—and indeed of a truly cold one—the species have little reason for reflecting the influences of the orthodox seasons.

Short spells of either abnormally moist or abnormally dry weather, abnormally warm or abnormally cool weather, together with local edaphic and topographic conditions, seem to be of more importance in deciding the periods of production of flowers and of fruits than does the mere following round of the seasons of the year.

\* Citations given at end of Appendix I.

For the sake of eliminating so far as possible the complications introduced by the individual behaviour of trees of the same species it has been found essential to observe definitely marked trees and a sufficiently large number of these, frequently, and over a lengthy period.

The *behaviour* table (*Table 1*)\* summarizes existing information concerning the seasons of flowering and fruiting of 63 species of trees and shrubs.

A feature of interest is the influence that proximity to the ocean has upon the date of general flowering and fruiting for all species dealt with in the Table. Individuals near the sea flower several weeks earlier than do those on the plateaux inland, whereas those on the plateaux flower and fruit several weeks to several months before their relatives in the mountain-kloof patches. Despite careful investigation and consideration, the reason for the definite gradation is not explicable. Temperature differences among the littoral, the plateaux, and the mountain-kloofs are very slight—averaging 3 degrees Fahr. between littoral and plateaux, and 5 degrees Fahr. between littoral and the mountain-kloofs, the littoral being the warmest of the three localities. The differences in relative humidity and rainfall are certainly more marked: the relative humidity on the littoral is 5-10 per cent. lower than that on the plateaux, and the mountain-kloofs experience a humidity 2 to 4 per cent. higher than the plateaux; the rainfall on the littoral is 10 to 15 inches lower than that experienced by the plateaux and 20 to 30 lower than that obtained by the mountain-kloof patches. The light intensity in the three types of locality, for all practical purposes, is the same. The slightly warmer and rather drier conditions holding at the littoral may possibly account for the earlier appearance of Autumn, Winter, and Early-Spring flowering blossoms, but in the opinion of the writer can scarcely be considered responsible for the earlier appearance of those blossoms opening in Summer.

There is a tendency for individuals of certain species, e.g. *Platylophus trifolius*, *Cunonia capensis*, *Nuxia floribunda*, *Chilanthus arborescens*, *Brachylaena nerifolia*, *Olea laurifolia*, and *Apodytes dimidiata* to flower slightly earlier as the West is approached *within the George-Knysna-Zitzikamma Forest region*. The reason for this behaviour is not clear, for in both Winter and Summer the temperature becomes slightly lower as one progresses Westward, while the rainfall scarcely alters.

Flowering is sometimes further advanced, species for species, on northern, north-western, and north-eastern aspects than on the cooler southern, south-western, and south-eastern.

Northern, north-western, and north-eastern sides of trees often show masses of flowers several weeks before these appear on the sides opposite. As has been described by the writer (1926: "2") in the instance of *Virgilia capensis*, the reason for this phenomenon is to be found in the greater degree of light available on the northern, north-western, and north-eastern sides, and in the occurrence of a higher local temperature on these sides, more especially during the Winter months.

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† Tables given at end of Appendix I.

## 2. Quantity and Efficiency of the Flowers.

(a) *Quantity*.—In full flowering seasons the amount of flowers borne by the individual tree varies according to proximity to the ocean, aspect, light-intensity, degree of soil-moisture, age and nature of the tree, and naturally according to species. Trees near the ocean, on the whole, flower slightly more profusely than do those inland; trees on western, northern, north-western, and north-eastern aspects more profusely than those on eastern, southern, south-western, and south-eastern.

Marginal or isolated trees experiencing stronger light-intensity than those within the forests or under canopy, flower more abundantly than the latter. Trees occurring in the drier forests usually bear richer crops than those in moist forests, but considerable variation according to species, is found—thus *Podocarpus* spp., *Elacodendron* spp., *Celastrus burifolius*, *Pterocelastrus*, *Plectronia* spp., *Ekebergia*, *Myrsine melanophleos*, *Trichocladus* spp., *Ochna* spp., *Olinia cymosa*, and *Sideroxylon*, flower best in the drier forests, whereas *Cunonia*, *Platylophus*, *Nuxia*, *Sparmannia*, and *Brachylaena neriifolia* flower best under moist conditions, while *Ocotea*, *Halleria*, *Apodytes*, *Gonioma*, *Trimeria alnifolia*, and *Olea laurifolia* show the richest flower crops under medium-moist conditions. Adult trees bear more heavily than large immature ones, and large, over-mature, often more heavily than mature. Diseased or otherwise damaged, and burnt individuals frequently bear heavier crops of flowers than normal ones.

The average, normal, adult individual growing under normal forest conditions, in full flowering seasons, bears flowers to the extent described below, according to species:—

- (i) *Flowers very abundant*: (24 species, or 38.1% of the 63 spp. studied).

*Podocarpus elongata* L'Herit, *P. Thunbergii* Hook, *Olea laurifolia*, *O. capensis*, *Ocotea* *Apodytes*, *Curtisia*, *Platylophus*, *Cunonia*, *Nuxia*, *Chilianthus arboreus*, *Olinia cymosa*, *Ilex*, *Myrsine melanophleos*, *Fauvea MacNaughtonii*, *Pterocelastrus variabilis*, *Celastrus burifolius*, *Halleria*, *Plectronia obovata*, *Sideroxylon*, *Brachylaena neriifolia*, *Tarchonanthus*, *Ekebergia*, *Rhamnus*.

- (ii) *Flowers abundant*: (20 species, or 31.8% of the 63 spp. studied).

*Olea foveolata*, *Cassinopsis capensis*, *Kiggelaria*, *Doryalis rhamnoides*, *Virgilia*, *Acokanthera renenata*, *Elacodendron crocum*, *E. capense*, *E. Kraussianum*, *Celastrus acuminatus*, *C. peduncularis*, *Plectronia Mundtii*, *P. ventosa*, *Royena lucida*, *Euclea macrophylla*, *E. lanceolata*, *E. racemosa*, *Rhus laurigata*, *Lachnostylis*, *Ficus capensis*.

- (iii) *Flowers in moderate numbers*: (12 species, or 19% of the 63 spp. studied).

*Widdringtonia cupressoides*, *Trimeria alnifolia*, *Calodendron*, *Toddalia lanceolata*, *Fagara Dargi*, *Burchellia*, *Sparmannia*, *Trichocladus crinitus*, *T. ellipticus*, *Ochna arborea*, *O. atropurpurea*, *Celtis rhamnifolia*.

- (iv) *Flowers few*: (5 species, or 7.9% of the 63 spp. studied).  
*Scolopia Mundtii*, *S. Zeyheri*, *Gonioma*, *Scutia*, *Carissa arduina*.
- (v) *Flowers very few*: (2 species, or 3.2% of the 63 spp. studied).  
*Gardenia Rothmannia*, *Pittosporum*.

It is seen that about 70% of the species studied, bear flowers in some abundance. There are several factors that make it necessary that large numbers of flowers should be produced, the more important of these being as follows:—

- (a) *Uncongenial atmospheric conditions*: dry, hot Foehn ("Berg") winds that shrivel the flowers; strong gales that toss thousands to the ground; heavy rains that beat the flowers to pieces; dry weather and high degree of insolation that kill buds and open blossoms alike, still, warm, humid weather that favours parasitic Fungi and Insects.
- (b) *Biotic foes*: especially Aphids (*Olinia cynosa* suffers severely) and Psyllidae (Apodytes, *Olea laurifolia*, *O. capensis*, *O. forcolata*, are often attacked with severity) among Insects, and *Pestalozzia* sp. nov. (*Ocotea bullata*), *Capnodium* spp. (all species), and an unidentified fungus attacking the flowers of *Nuxia floribunda*. The birds *Zosterops capensis* and *Estrilda astrilda* often do considerable harm to flowers in their attempts to find Insects hidden in the latter.
- (c) *The possibility of a dearth of pollinating agents*: in some years Honey Bees are less abundant than normal, this being due to disease and to nature of the weather. Nectariniidae are less numerous in some years than others, the causes being uncongenial weather during the brooding and hatching periods and scarcity of food.

Were small flower crops borne it is more than likely that the output of fruits by some of the tree and shrub species would be inadequate to account for the successful regeneration of their kind.

(b) *Efficiency*.—The degree of efficiency of the flowers with respect to fertilization, is described in the final column of *Table II*, species by species.

Summing up the data therein given, it is seen that—

- 8 species (12.6%) show a *very low* degree of efficiency (1%-5%);
- 39 species (61.9%) show a *low* degree of efficiency (6%-20%);
- 13 species (20.6%) show a *medium* degree of efficiency (21%-40%);
- 3 species (4.9%) show a *high* degree of efficiency (41%-80%).

It is interesting to observe the following:—

- (a) Of the 24 species that bear flowers *very abundantly*,  
 1 sp. bears flowers of *very low* degree of efficiency;  
 11 spp. bear flowers of *low* degree of efficiency;  
 9 spp. bear flowers of *medium* degree of efficiency;  
 3 spp. bear flowers of *high* degree of efficiency.

XXVII.

CLIMA X FOREST

GRADUAL DEVELOPMENT  
OF SAPLINGS TO POLES AND TREES:

# SCHEMATIC CHART SHOWING THE MAIN STAGES IN FOREST SUCCESSION AFTER FIRE.

DEATH OF PIONEERS  
AFTER  
ESTABLISHMENT OF  
REGENERATION OF TREE SPP.

DEVELOPMENT AND  
DECREASE IN LUXURIANCE  
OF SHOOTS

IF SHADED BY SHOOTS  
(e.g. HALLERIA) GLEICHENIA  
DECREASES IN LUXURIANCE  
  
GLEICHENIA CONSOCIATES  
(WHICH MAY REMAIN SUBCLIMAX)

PSORALEA CON-  
SOCIATES 10/12 FT  
IN 2-3 YEARS

CASSIA CONSOCIATES  
AND ASSOCIATES  
15-18 FT IN 5 YEARS

VIRGILIA CAPENSIS  
CONSOCIATES  
25 FT IN 5-8 YEARS

GLYSTIA COMMUNITIES  
AND HALLERIA LUCIDA  
SHOOTING 12-18 FT IN 2-5 YEARS.

APPEARANCE OF  
GLEICHENIA POLYPODIUMS

PSORALEA PINNATA  
SEEDLINGS

CASSIA OCCIDENTALIS  
" TOMENTOSA,  
SEEDLINGS.

VIRGILIA SEEDLINGS

DENSE WEED  
COMMUNITIES

e.g. *Hesperium*, *Polypodium*, *H. polifolium*, *H. diffusum*,  
*H. folium*, *H. porphyllum*; *Hippia* four-seed  
*Gleditsia pilosa*; *Asclepias*, *Polypodium*, *Polypodium*,  
*Rubus*, *Sip. Cyperaceae*, *Paspalum*,  
*Cyperus*, *Eleusine*, *Eleusine*,  
CANTERBURY, *ERIGLOIDES*.





- (b) Of the 20 species that bear flowers *abundantly*,  
 3 spp. bear flowers of *very low* degree of efficiency;  
 15 spp. bear flowers of *low* degree of efficiency;  
 2 spp. bear flowers of *medium* degree of efficiency.
- (c) Of the 12 species that bear flowers in *moderate numbers*,  
 3 spp. bear flowers of *very low* degree of efficiency;  
 8 spp. bear flowers of *low* degree of efficiency;  
 1 sp. bears flowers of *medium* degree of efficiency.
- (d) Of the 5 species that bear *few* flowers,  
 1 sp. bears flowers of *very low* degree of efficiency;  
 4 spp. bear flowers of *low* degree of efficiency.
- (e) Of the 2 species that bear *very few* flowers,  
 1 sp. bears flowers of *low* degree of efficiency;  
 1 sp. bears flowers of *medium* degree of efficiency.
- (f) When the 44 species producing *very abundant* and *abundant* flowers are combined, it is seen that  
 10% are of *very low* degree of efficiency;  
 60% are of *low* degree of efficiency;  
 23% are of *medium* degree of efficiency;  
 7% are of *high* degree of efficiency.
- (g) When the 19 species producing *moderate numbers*, *few*, and *very few* flowers, are combined, it is seen that  
 21% are of *very low* degree of efficiency;  
 68.5% are of *low* degree of efficiency;  
 10.5% are of *medium* degree of efficiency.

Thus, on the whole, the species producing *very abundant* and *abundant* flowers, are rather more efficient than those producing flowers in *moderate numbers*, *few* flowers, and *very few* flowers.

### 3. Pollination.

Cross pollination is carried out chiefly by *Apis mellifica* and *A. caffra*; *Anthophora* and *Xylocopa* spp. play some part, while Lepidoptera, Diptera, and Ants are relatively unimportant. Nectariniidae (*Cinnyris afer*, *C. chalybeus*), *Promerops cafer*, *Zosterops capensis*, and *Estilda astrilda*, account for the pollination of several species. Wind pollination is relatively unimportant, except in the instances of the anemophilous *Podocarpus elongata* L'Herit., *P. Thunbergii* Hook., *Widdringtonia cupressoides*, and the partially anemophilous *Trichocladus crinitus*, *T. ellipticus*, *Trimeria alnifolia*, *Brachylaena verticillata*, *Tarchonanthus camphoratus*, *Lachnostylis capensis*.

The flowers may be classified with respect to Colour, Odour, Pollination Agents and Degree of Fertilization, as shown in *Table II*.

Competition for pollination is not particularly keen among the indigenous species of trees and large woody shrubs at the Knysna.

This is due to two main causes: (a) It is only very occasionally that two or more abundantly flowering species are in blossom at identically the same time; (b) the Honey Bee, which is the most important agent of pollination, selects pollen from some species, nectar from others, and thus distributes its favours fairly evenly.

A point of considerable interest and of some importance biologically, is the increasing attraction that exotic trees—*Eucalyptus* spp.

particularly—have for the Honey Bee. Exotics near the Forests and several miles removed therefrom, are constantly visited by swarms that have their headquarters in the indigenous Forests.

Often swarms endeavour to make their headquarters in exotic plantations, and will put up with much hardship so far as sites for their hives are concerned if the Eucalypt flowers are profuse and in tempting condition. The role of the Honey Bee in bringing about hybridization of the Eucalypts will probably repay investigation.

#### 4. *Nature of the Fruits, and Seeds.*

The nature of the fruits and seeds of the more important Forest trees and large shrubs is summarized in *Table III*.

#### 5. *Dispersal of Fruits and Seeds.*

*Table 3* shows that the larger number of the fruits are either drupaceous or baccate. Judging from this, one would conclude that the major role in seed dispersal is played by birds and mammals.

Observation supported by the examination of faeces, of shot birds and mammals, and experimental sowings of known numbers of fruits or seeds upon quadrats placed under close observation, proves this supposition to be correct.

As information concerning the parts played by the various Forest birds and mammals in fruit and seed dispersal is exceedingly meagre—apart from passing reference by Marloth (1894) and in several of Bews's ecological papers there is no literature—the following summary of results obtained after some  $3\frac{1}{2}$  years careful work on this important subject is of interest:—

Following Clements (1905; 1907; 1916), the subject of *dispersal* is divided into *simple aggregation* and *migration*. *Simple aggregation* may be defined as the grouping of fruits and seeds about the plant producing them; *migration* is the process whereby a fruit or seed is borne to an area beyond that directly influenced by the parent plant. In dealing with trees the writer (1924: 286; 1925: 156), has used the term "*crown-influence-zone*" to express the area immediately sheltered or otherwise influenced by the crown; movements of germules within this zone are considered as *simple aggregation*, and those beyond as *migration*. The line of division between *simple aggregation* and *migration* is not a clear-cut one, for obviously movement within the *crown-influence-zone*, no matter how insignificant is in a sense *migration*. Reasons for drawing what may appear to be an unnecessarily fine distinction between the processes are:—(a) movement within the *crown-influence-zone* bears a different relation to germination, establishment and growth, from movement beyond that zone; (b) *simple aggregation* increases the individuals of a species, thus tending to produce dominance, while *migration* has the opposite effect—general mixing of species.

(a) *Simple Aggregation*.—Of the millions of fruits borne by the Forest trees of the Kuysna seldom more than *from less than 1 per cent. to 10 per cent.* (varying with species and locality) ever move beyond the *crown-influence-zones* of the parents.

This is demonstrated by capsule, drupe, berry, and cone bearing species alike, the proportion of migration being higher in the species that produce drupes or berries of edible nature.

*Platylophus trifolius*, *Cunonia capensis*, *Nuxia floribunda*, *Chilianthus arboreus*, are examples of capsule-bearing species. The writer (1925: 156), has shown that as many as 10,048 capsules of *Platylophus* may fall upon 1 square metre of the crown-influence-zone in the course of a single fruiting season. *Cunonia capensis*, the capsules of which contain about 40 minute seeds each, often sheds several hundred thousand germules per square metre. Despite the possession of membranous wings the seeds are very seldom wind borne; they are destroyed by water; birds and mammals do not carry them except by accident; they therefore accumulate under the parent tree by the million. *Nuxia floribunda* and *Chilianthus arboreus* repeat the tale of the two species just mentioned.

Edible drupes and berries are borne by *Ocotea bullata*, *Olea laurifolia*, *O. capensis*, *O. foveolata*, *Elaeodendron capense*, *E. croceum*, *Ekebergia capensis*, *Ilex capensis*, *Halleria lucida*, *Olinia cymosa*, *Curtisia faginea*, *Myrsine melanophleas*, *Sideroxylon inerme*, *Plectronia obovata*, *P. Mundtii*, *P. ventosa*, *Doryalis rhamnoides*, *Rhamnus prinoides*, *Scutia Commersonii* and other species, and fruits with succulent and edible arils by *Podocarpus* spp., yet the percentage of the crops borne that migrates is small in every instance. The largest percentage of migration are exhibited by *Olea laurifolia*, *O. capensis*, *O. foveolata*, *Podocarpus* spp., *Halleria lucida*, *Elaeodendron capense*, *E. croceum*, intermediate values by *Ekebergia capensis*, *Olinia cymosa*, *Myrsine melanophleas*, and *Ocotea bullata*, and the smallest, almost negligible values by *Ilex capensis*, *Curtisia faginea*, *Plectronia* spp., *Doryalis rhamnoides*, *Sideroxylon inerme*, *Rhamnus prinoides* and *Scutia Commersonii*.

Non-palatable fruits such as those of *Apodytes dimidiata*, *Cassinopsis capensis*, and *Fagara Daryi*, and poisonous ones such as those of *Acokanthera venenata*, are still more confined to the area influenced by the crown of the parent.

Aggregation does not by any means result in producing dense stands of seedlings on the crown-influence-zone in every instance. The species of tree, the community and habitat conditions, and the very concentration of fruits itself, often inhibit successful germination and establishment; Fungi and Insects of parasitic and predaceous nature often become rampant owing to the accumulation of fruits, while in dense stands of young seedlings competition for moisture and solutes as well as for very space itself is so intense that death of large proportions of the seedling-communities takes place.

(b) *Migration*.—Migration in all species (except *Virgilia capensis*, *Podocarpus elongata*, *Olea laurifolia*, *Olea capensis*, *Olea foveolata*, *Elaeodendron capense* and *E. croceum* in occasional instances) is over very short distances—seldom exceeding distances from a few yards to several miles. The fruits or seeds of the species above mentioned, however, may be borne by streams and rivers (e.g. *Virgilia*, *P. elongata*, *Olea* spp.) for considerable distances, or by far-flying birds (all spp. listed except *Virgilia*).

Examination of *Macchia* at various distances—from several hundred yards to several miles—has shown the presence of scattered seeds of the species listed except *Virgilia*, in bird and mammal faeces. Young seedlings are to be found in localities that have not been burnt for several years and that have provided suitable conditions for germination and establishment.

Owing to demands of space it is not possible to list the various species of fruit according to each of the many bird and mammal agents responsible for their dispersal, but a general classification of the species of fruits under the main headings "Birds and mammals" is furnished, together with notes concerning the principal migration agents. Wind and water borne fruits are dealt with as well. (Vide *Table IV.*)

The relation of fruit and seed dispersal to general distribution of species is a complicated subject, but at all events two important generalizations can be made respecting it. (1) Migration has been an exceedingly slow process in the instance of most of the South African Forest trees, owing not only to difficult conditions of both habitat and community, but also to the relatively inefficient means of dispersal. (2) During the course of the ages birds and mammals have played a most important part in the distribution of plants; it is a striking feature in Macchia and Scrub that the Forest species advance along and from moist kloofs and stream and river beds—birds and mammals frequent such localities and supply them with the germules of Forest spp.

#### 6. Germination and Establishment.

The related subjects of viability of seeds, germination, and establishment of seedlings of the more important tree species have been submitted to quantitative, experimental study since January, 1923. A summary of available information relating to viability of seeds, chief agents of mortality, and average period required for germination under normal Forest conditions is provided in *Table V.* The subject of establishment of young regeneration has been studied by quadrat methods. In *Table VI* is summarized information at present available concerning the degree of successful establishment and the principal biotic causes of poor growth or death, for the principal Forest species.

Concerning regeneration there are in addition several points of general importance requiring record:—

Regeneration for one and the same species varies considerably in quantity and quality according to locality. Thus—*Hemitelia capensis*—clad areas (on which also occur *Blechnum capense*, *Marattia fraxinea*, and various smaller ferns) of low Light-intensity (1/500 to 1/1,000 at seedling level on bright, clear days from 11 a.m. to 3 p.m., when the Light-intensity under full exposure to the sun is 1—per Clements's Stopwatch Photometer), high Relative Humidity (an average of from 85 to 95 per cent.), high Holard (from 120 to 220 per cent. on dry-weight of ovened samples), and high soil-acidity (pH 4.0 to pH 4.4 at 6 inches below the surface) support little or no regeneration. Germules falling upon such areas meet with many factors inimical to their germination so that the mortality percentage is high: such as do germinate produce weakly plants that are either killed by parasitic Fungi and Insects and by physiological diseases, or establish themselves with difficulty and grow exceedingly slowly. There are, too, the extensive *Trichocladus crinitus* layers typical of medium-moist and dry Forests: these dense layers cut down the Light-intensity considerably (from 1/500 to 1/350 on bright clear days from 11 a.m. to 3 p.m., when the Light-intensity is 1—per Clements's Stopwatch Photometer). The *Trichocladus* removes much of the moisture from the upper 6 to 9 inches of the soil, the

small and relatively delicate seedlings of Forest tree species being unable to compete with it successfully. While there usually are many more seedlings under *Trichocladus* than there are under the *Hemitelia* layers, the stocking of young plants is nevertheless very poor.

Areas from which *Hemitelia* and *Trichocladus* and the dense communities of *Aspidium capense* Willd. (*Polystichum adianteforme* J. Sm.) are absent, or areas on which they are sparse, usually show very fair regeneration of most species. Dense layers of the tall, luxuriant *Plectranthus fruticosus*, and of *Carex aethiopica*, are frequently found in moist Forest; these cut down the Light-intensity as much as does the *Hemitelia*, while the Holard of the areas covered by them is often high (from 80 to 120 per cent. on dry-weight of ovened samples) and the pH values low; (from pH 4.3 to pH 4.8)—such communities do not allow of the establishment of regeneration of tree species beneath their cover.

Considering the complex nature of the primeval Forests and the various peculiarities of the constituent species and putting aside the poverty of regeneration under dense communities of ferns and shrubs and tall herbs, the natural regeneration must be looked upon as excellent. There is certainly more regeneration in an average portion of Knysna primeval Forest than there is in equivalent portions of many of the best mixed Forests of the British Isles and of Europe.

Assistance from the Forester in the directions of introduction of more light to a regulated degree, and decrease of competition with various useless shrubs and weeds, results in the production of more and of better-class regeneration. Excessive removal of high cover, however, usually results in either death or stunting of the existing regeneration, while fresh plants are prevented from developing on account of the dense light-demanding and light-bearing weeds (e.g. *Helichrysum petiolatum*, *H. parviflorum*, *H. diffusum*, *Rubus fruticosus*, *R. pinnatus*, *Hydrocotyle* spp., *Plectranthus fruticosus*, and *Carex aethiopica*) that immediately appear.

Such plants as appear simultaneous with the first weeds are very often lesioned at the collars by the excessive temperature of the soil surface. (140 to 165 deg. Fahr. from noon to 3 p.m. on hot summer or winter days.)

After the dense weed communities have been killed out or weakened by the shade cast by coppice of *Halleria lucida*, and by fast growing shrubs such as *Cluytia pulchella*, *C. affinis*, *Rhamnus prinoides*, *Ostcospermum moniliferum*, and *Polygala myrtifolia*, regeneration of the best tree species is able to establish itself and to develop more rapidly than under the dense cover of unexploited primeval Forest. Thorough defeat of the weeds, however, may be delayed for periods ranging from 5 to over 20 years.

The mortality figures for the regeneration of certain species are very high, but this is to be expected as the output of seedlings is in these species extravagantly superabundant; death of large numbers of the plants is an essential to the successful development of a few. The mortality factor is fully discussed in a paper to appear later.

A point of the very greatest interest, but one not at all easy to explain, is the truly excellent manner in which the Yellow-wood, *Podocarpus Thunbergii* Hook (*P. latifolius* R.Br.) regenerates.

*Podocarpus* is a relatively primitive conifer, although it does not appear to have been recorded from beds earlier than the Miocene (*vide* Knowlton's list in "Plant Succession," F. E. Clements, 1916).

It might be suggested that the Knysna Forests were in past ages pure *Podocarpus* communities, and that these Gymnosperms are being slowly ousted by Angiospermous trees; this supposition, however, is certainly not supported by the present efficient manner in which *P. Thunbergii* (and in places, *P. elongata* L'Herit as well) regenerates. Perhaps the regeneration process, though still so excellent, has with the centuries gradually decreased in efficiency, and possibly the incoming hordes of Flowering trees and shrubs are slowly but surely gaining the upper hand.

#### SUMMARY.

1. The behaviour of some 63 species of trees and shrubs occurring in the Knysna forests with respect to seasons of flowering and fruiting is described in tabular form. (*Table I.*)<sup>\*</sup>

The influence of proximity to the sea is discussed.

2. The quantity of the flowers produced by certain species and the efficiency of these flowers are described in general.

3. Principal agents of pollination are listed for each of the 63 species, and the degree of efficient pollination (that is of fertilization) is described for each. Colour and size, and odour of the blossoms are briefly described. (*Table II.*)

4. The nature of the fruits and seeds of the 63 species is summarized under the headings "Cones and Capsules," "Berries and Drupes," "Miscellaneous." (*Table IIIA IIIB IIIC.*)

5. Dispersal of the fruits and seeds of the 63 species is summarized under heading of the principal agents of dispersal: Wind, Water, Birds, Mammals, Man, and Various. (*Table IV.*) Dispersal is generally discussed, and the desirability of employing the *Aggregation* and the *Migration* concepts is touched upon.

6. Information relating to viability, chief agents of mortality, and average period required for germination of seeds, is summarized in *Table V.*

7. Degree of establishment and principal biotic agencies of disease and destruction are described in *Table VI.* Apart from areas overstocked with *Hemitelia capensis* and other ferns, and with *Trichocladus crinitus*, the forests are well stocked with regeneration and compare favourably with mixed hardwood forests in Europe and the British Isles.

8. The summarized information given in the six tables is the result of phenological studies of definitely marked trees over a period of about 3½ years, study of the structure of fruits and flowers, pollination experiments under natural and under controlled conditions, observations and experiments connected with the dispersal of fruits and seeds, and nursery and quadrat germination experiments.

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<sup>\*</sup> Tables of Appendix I.

## REFERENCES TO LITERATURE CITED IN APPENDIX I.

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Table I.

## FLOWERING AND FRUITING SEASONS; MORE IMPORTANT KNYNSA FOREST TREES AND SHRUBS.

Species.	Flowering Seasons (Full).	Usual Time of the Year.	Fruits are Mature.	Fruits are Fallen.	Periods Separating Full Fruiting Seasons.
<i>Podocarpus elongata</i> L. Heit.	Every 2nd or 4th year	August-October.....	9-12 months after fertilization	10-15 months after fertilization	Every 2nd or 4th year.
<i>Podocarpus Thunbergii</i> Hook	Every 2nd year, but a few flowers every year	August-October.....	6-9 months after fertilization	7 to 12 months after fertilization	Every 2nd year.
<i>Widdingtonia cupressoides</i> , endl.	Every year.....	September-October.....	12 months after fertilization	Seeds escape 18-24 months after fertilization	Every 2nd year.
<i>Olea laurifolia</i> , Lamk....	Variable, may take place 2nd, 3rd, or 4th year	January-May.....	12-18 months after fertilization	A large proportion fall prematurely; viable fruits fall 15-18 months after fertilization	Full flower crops usually produce full fruit crops, hence latter may occur every 2nd, or 3rd or 4th year.
<i>Olea capensis</i> L.....	Every year.....	August-January.....	6-8 months after fertilization	As soon as mature many fall prematurely	Full crops annually.
<i>Oleo foveolata</i> E. Mey..	Every 3rd year.....	September-December...	6-7 months after fertilization	As soon as mature; many fall prematurely	Full crops once in 3 years.
<i>Ocotea bullata</i> , E. Mey..	Variable—some trees every month in every year, some at intervals of 6, 12 24 months	Any month.....	13-2 months after fertilization; tardy reach mature size or colour on tree	Usually fall prematurely	Very variable—from several months to several years according to tree and site.
<i>Apodytes dimidiata</i> , E. Mey.	Variable—every 2nd or 3rd or 4th year according to tree and site	November-February....	6-8 months after fertilization	Mostly fall prematurely; mature fruits fall 6-9 months after fertilization	Some flower-crops produce no fruits; full crops usually every 3rd year.
<i>Cassinopsis capensis</i> Sond.	Every year.....	October-March.....	3-4 months after fertilization	Fall as soon as mature	Full crops annually.
<i>Curtisia laginca</i> , Alt.....	Usually every year.....	Variable, but often October-March	6-10 months after fertilization	7-12 months after fertilization	Poor fruit-crops at times follow good flower-crops; this is due to a fungus which galls the flowers; most trees, however, produce fair crops every year.
<i>Platylophus trifoliatus</i> , Don.	Every year.....	December-February.....	6-8 weeks after fertilization	8-10 weeks after fertilization	Heavy crops annually.

Table I.—(Continued).

## FLOWERING AND FRUITING SEASONS; MORE IMPORTANT KATYNSA FOREST TREES AND SHRUBS.

Species.	Flowering Seasons (Full).	Usual Time of the Year.	Fruits are Mature.	Fruits are Fallen.	Periods Separating Full Fruiting Seasons.
<i>Cumonia capensis</i> L.....	Every year; some trees every 2nd year	February-May, or June-August	4-7 weeks after fertilization	6-9 weeks after fertilization—the entire fruiting spike falling	Heavy crops annually, unless flowers of the season happen to be diseased.
<i>Nuxia floribunda</i> Benth.	Every 2nd year.....	May-August.....	4-6 weeks after fertilization	Fruits persist for 3-4 months	Heavy crops usually follow the flower-crops unless the latter are fungus-injected.
<i>Chilanthus arborescens</i> A. DC.	Every year.....	August-January.....	14-2 months after fertilization	Seeds escape as soon as mature	Full crops annually.
<i>Olinia cymosa</i> , Thunb....	Variable; may occur every 2nd, 3rd or 4th year	June-November.....	10-14 months after fertilization	12-24 months; some are long persistent on the branches	Every 3rd or 4th year; some flower-crops are followed by very poor fruit-crops or by no fruits at all.
<i>Ilex</i> (capensis) miqf., Radlk.	Every year.....	October-February.....	2-3 months after fertilization	Fall as soon as mature	A few fruits each year, but full crops every 3rd year.
<i>Kiggelaria africana</i> L....	Every 2nd or 3rd year, but a few flowers every year	November-January.....	2-3 months after fertilization	Fall as soon as mature.	Heavy crops at 3-year intervals, but a few fruits occur every year.
<i>Sceloparia Mundtii</i> Arn....	Every 2nd year.....	December-May.....	3-4 months after fertilization	Fall as soon as mature.	Fruits appear in alternate years—always few.
<i>Sceloparia Zeyheri</i> , Nyl....	Every 2nd year.....	December-May.....	3-4 months after fertilization	Several days after maturity	Fruits appear in alternate years—seldom abundant.
<i>Trimeria albigata</i> Planch.	Every year.....	November-April; females slightly earlier than males	1-1½ months after fertilization	Capsules persist 2-4 weeks after maturity	Full crops annually.
<i>Diospyros thamoides</i> Burch.	Every year.....	September - February; females slightly earlier than males	3-4 months after fertilization	As soon as mature; many fall prematurely	Fruits very rarely—reputed full crops at 7-9 year intervals; intervals certainly not less than 4 years.
<i>Myrsine melanophloeos</i> R. Br.	Every 2nd year.....	July-August.....	2-3 months after fertilization	3-4 months after fertilization; some persist for many months	Heavy crops every 2nd year.

Table I.—(Continued.)

## FLOWERING AND FRUITING SEASONS : MORE IMPORTANT KNYENA FOREST TREES AND SHRUBS.

Species.	Flowering seasons (Full).	Usual Time of the Year.	Fruits are Mature.	Fruits are Fallen.	Periods Separating Full Fruiting Seasons.
<i>Faurea MacNaughtonii</i> , Phil.	Annually ; rarely at 2-year intervals	March-May.....	6-8 weeks after fertilization	9-12 weeks after fertilization ; some long persistent	Good crops usually annual, unless weather at time of flowering be very wet.
<i>Virgilia capensis</i> Lamk..	At 6-12 month-intervals, but very variable	Any month, but chiefly July-September	3-4 months after fertilization	5-6 months after fertilization ; some persist for over 12 months	Very variable ; some flower-crops produce no fruits, others large numbers ; usually a good crop once per year.
<i>Gonioma Kumasii</i> , F. Mey.	3 or more years separate the seasons ; a few flowers may be borne every year by some individuals	Usually October-April, but rather variable	6-8 weeks after fertilization	The light, winged seeds escape immediately the follicles open ; follicles open 1-3 weeks after they are fully mature	Heavy flower crops in some instances produce very full fruit-crops, but in others, very poor ones.
<i>Carissa acutina</i> Lamk..	Every year.....	October-March.....	1½-2 months after fertilization	As soon as mature ; many fall prematurely	In forests fruits rarely ; intervals between fair crops not less than 4 years.
<i>Anokanthera venusta</i> G. Don.	Every year.....	August-March.....	2-3 months after fertilization	1-2 weeks after maturity	Full crops annually.
<i>Calodendron capense</i> Thunb.	Annually ; some trees in alternate years only	November-January, some trees as late as early March	6 months after fertilization	About 7 months after fertilization the woody capsules dehisce	Poor fruit crops the rule.
<i>Toddalia lanceolata</i> Lam.	Every year.....	November-March.....	2-3 weeks after fertilization	2-3 weeks after maturity	At 2 year intervals.
<i>Fagara Davyi</i> Verdoorn..	At 3 year intervals.....	November-May.....	1-1½ months after fertilization	2-4 weeks after maturity ; some persistent several months	At 3 year intervals.
<i>Pterocelastrus variabilis</i> , Sond.	Annually in many instances ; other trees in alternate years only	September-February....	2-3 months after fertilization	Seeds escape several weeks after capsules are mature	Alternate years see the production of good crops.
<i>Elaeodendron</i> , <i>procum</i> (Thunb.) D.C. and E. capense E. and Z.	Annually in most instances ; some trees at intervals of 2-3 years	November-February....	10-12 months after fertilization	1-1½ months after maturity ; some are persistent for 3-4 months	Rarely 1 year, usually 2 years between fruit crops.

Table 1.—(Continued.)

## FLOWERING AND FRUITING SEASONS; MORE IMPORTANT KNYNSA FOREST TREES AND SHRUBS.

Species.	Flowering Seasons (Full).	Usual Time of the Year.	Fruits are Mature.	Fruits are Fallen.	Periods Separating <i>Fall</i> Fruiting Seasons.
<i>Elaeodendron Kraussianum</i> , Sm.	Every year.....	January-May.....	3-4 months after fertilization	as soon as mature.....	Every year some fruits; full crops 2-3 year intervals.
<i>Celastrus acuminatus</i> L..	Every year.....	December-March.....	2 months after fertilization	As soon as mature.....	Full crops annually.
<i>Celastrus peduncularis</i> .	Every year.....	November-March.....	2 months after fertilization	As soon as mature.....	Full crops annually.
<i>Celastrus buxifolius</i> , L..	Every year.....	September-January.....	2-2½ months after fertilization	2-4 weeks after maturity	Full crops annually.
<i>Halleria lucida</i> L.....	Annually.....	July-September.....	3 months after fertilization	The larger proportion before they are mature; those that do reach maturity fall immediately they are ripe	Annually.
<i>Plectronia</i> spp. ( <i>P. obovata</i> , Sm., <i>P. Mundtii</i> , <i>P. ventosa</i> ) L. Pappé	Usually annually; some trees miss alternate years	November-February....	3-4 months after fertilization	As soon as mature.....	Many trees bear full crops annually, others miss alternate years.
<i>Burchellia capensis</i> DC..	Annually; some trees miss alternate years.	October-February.....	3-4 months after fertilization	6-8 months after fertilization; some are very long persistent	Most trees bear annually; some miss alternate years.
<i>Gardenia Rothmannia</i> L.	Annually.....	October-March.....	3-4 months after fertilization	1-2 months after maturity is reached	Annually.
<i>Royena lucida</i> , L.....	Annually.....	August-November.....	3-4 months after fertilization	As soon as mature; a large proportion fall before maturity is reached	Annually.
<i>Euclea</i> spp. ( <i>E. macrophylla</i> , E. Mey., <i>E. laevis</i> , Murr., <i>E. lanceolata</i> , E. Mey.)	Annually.....	December-March.....	2 months after fertilization	As soon as mature.....	Very irregular; some at 2 year intervals, others at 3-4 more year intervals.
<i>Sideroxylon inerme</i> L....	Every year.....	September-March.....	3-4 months after fertilization	Persist 2-3 weeks after they reach maturity	Full crops annually.
<i>Rhus laevigata</i> L.....	Every year.....	October-February.....	2 months after fertilization	Fall soon after maturity	Full crops annually.
<i>Brachylaena nerifolia</i> R.Br.	Every year.....	December-February; females earlier than males	2-3 weeks after fertilization	As soon as mature; many fall prematurely	Full crops annually.

Table I.—(Continued.)

FLOWERING AND FRUITING SEASONS; MORE IMPORTANT KNYNSA FOREST TREES AND SHRUBS.					Periods Separating Full Fruiting Seasons.	
Species.	Flowering Seasons (Full).	Usual Time of the Year.	Fruits are Mature.	Fruits are Fallen.		
<i>Tarchonanthus camphoratus</i> L.	Every year.....	December-April; females earlier than males	3-4 weeks after fertilization	Persist for several weeks after mature		Full crops annually.
<i>Sparmannia africana</i> L.f.	Every year.....	October-June.....	4-6 weeks after fertilization	Seeds escape as soon as mature		Full crops annually.
<i>Trichoclades cuneatus</i> Pers.	Every year.....	December-May.....	1½-2 months after fertilization	Seeds escape soon as mature		Full crops annually.
<i>Trichoclades ellipticus</i> B. and Z. (rare and local)	Every year.....	January-May.....	1½-2 months after fertilization	Seeds escape soon as mature		Full crops annually.
<i>Ocnea arborea</i> Burch. ....	Every 2nd year.....	December-April.....	2-2½ months after fertilization	As soon as mature.....		Full crops every 2nd year.
<i>Ocnea arborea</i> Burch. ....	Every 2nd year.....	December-April.....	2-2½ months after fertilization	As soon as mature.....		Full crops every 2nd year.
<i>Ocnea atropurpurea</i> B.C.	Every 2nd year.....	December-April.....	2-2½ months after fertilization	As soon as mature.....		Full crops every 2nd year.
<i>Lachnostylis capensis</i> Thunz	Every year.....	October-January.....	2-3 months after fertilization	As soon as mature.....		Every 2nd year.
<i>Ekebergia capensis</i> Sparm.	Every year.....	October-March.....	4-5 months after fertilization	Persist 3-4 weeks after maturity		Every 3rd year.
<i>Ficus capensis</i> Thunb. ....	Every year.....	October-January.....	2-2½ months after fertilization	Persist 3-4 weeks after maturity		Full crops every 2nd year.
<i>Celtis rhombifolia</i> Presl.	Every 2nd year.....	October-February.....	1½-2 months after fertilization	Fall soon as mature.....		Full crops once in 4 years.
<i>Pittosporum viridiflorum</i> Sm.,	Every 3rd year, but very variable	November-February.....	3-4 months after fertilization	Several days after maturity		Very rarely produces full crops—at least 3-4 years between medium crops.
<i>Rhamnus prinoides</i> L'Herit	Every year.....	October-March.....	2-2½ months after fertilization	As soon as mature.....		Full crops annually.
<i>Seutia (indica)</i> Commersonii Brogni.	Every year.....	October-February.....	2-2½ months after fertilization	As soon as mature.....		Full crops rare in forests—2-3 years apart; outside forests full crops annually.

Table II.

## FLOWERS: KNYNSA FOREST TREES—COLOUR, ODOUR, POLLINATION.

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Species.	Colour and Size.	Odour.	AGENTS OF POLLINATION.							Degree of Efficient Pollination.†
			Self.	Wind.	Apis mellifica and A. castra.	Anthophora spp. and Xylocopa spp.	Lepidoptera.	Nectariniidae and Promerops Caffr.*	Various.	
Podocarpus elongata, L'Herit	Male, Cream Female, Green	Nil	—	‡	—	—	—	—	—	Low.
Podocarpus Thunbergii, Hook	Male, Cream Female, Green	Nil	—	‡	—	—	—	—	—	Low.
Widdringtonia cuneoides	Green	Nil	—	‡	—	—	—	—	—	Low.
Olea laurifolia.....	White or cream; minute	Sweet, sickly; medium	‡	—	‡Seeking pollen	—	—	—	—	Medium.
Olea capensis.....	White or cream; minute	Sweet, sickly; medium	‡	—	‡Seeking pollen	—	—	—	—	Medium.
Ocotea bullata.....	White or cream; minute	Laurel; faint	‡	—	—	—	—	—	—	Low (vide J. F. Phillips, 1924).
Olea foveolata.....	White or cream; minute	Laurel; faint	‡	—	‡Seeking pollen	—	—	—	—	Low.
Apodytes dimidiata.....	White or cream; minute	Sweet, rich, heavy; strong	‡	—	‡Seeking pollen	—	—	—	—	Low.
Cassinopsis capensis.....	Cream; minute	Sweet, faint	‡	—	‡Seeking pollen	—	—	—	—	Medium.
Curtisia faginea.....	Fawn to dirty cream; minute	Nil	‡	—	—	—	—	—	—	Medium.

\*† Details on page 267.

Table II.—(Continued).

## FLOWERS : KNYENA FOREST TREES—COLOUR, ODOUR, POLLINATION.

Species.	Colour and Size.	Odour.	Self.	Wind.	AGENTS OF POLLINATION.					Degree of Efficient Pollination.†
					Apis mellifera and A. castra.	Anthophora spp. and Xylocopa spp.	Lepidoptera.	Neotarniidae and Promecops Caller.	Various.	
<i>Platylophus trifolatus</i> .....	White or cream; minute	Sweet, rich heavy; strong	++	—	‡Seeking nectar	++	+	+	—	High (50 to 80 %.)
<i>Cunoula capensis</i> .....	White or cream; minute	Sweet; rich heavy; strong	+	—	*Seeking nectar	++	+	+	—	High.
<i>Nuxia floribunda</i> .....	White or cream; minute	Sweet, rich; medium	+	—	‡Seeking nectar and pollen	++	—	—	Ants, Melolonthinae, Diptera	Low.
<i>Chilanthus arboreus</i> .....	Cream; minute	Sweet, rich	+	—	‡Seeking pollen	—	—	—	Ants Diptera	Low.
<i>Olinia cymosa</i> .....	Cream; minute (sometimes few pink markings)	Rich almond; strong	+	—	‡Seeking nectar, but more often pollen	++	—	‡Especially if infected by Aphids	Aphid larvae	Low.
<i>Ilex mitis</i> .....	Cream; minute sometimes few pink markings)	Sweet; faint	++	—	‡Seeking pollen	—	—	—	—	Low.
<i>Kiggelaria africana</i> .....	(Dioecious) females larger than males, but minute, cream	Sweet; faint	—	—	‡Seeking nectar from females, pollen from males	—	—	—	—	Low.
<i>Scolopia Mundtii</i> .....	Cream; minute	Sweet; faint	+	—	‡Seeking pollen	—	—	—	—	Low.
<i>Scolopia Zeyheri</i> .....	Cream; minute	Sweet; faint	+	—	‡Seeking pollen	—	—	—	—	Low.

Table II.—(Continued).

## FLOWERS : KANSAS FOREST TREES—COLOUR, ODOUR, POLLINATION.

Species.	Colour and Size.	Odour.	AGENTS OF POLLINATION.						Degree of Efficient Pollination.*
			Self.	Wind.	Apis mellifica and A. castra.	Anthophora spp. and Xylocopa spp.	Lepidoptera.	Noctuidae and Promethops (aef.)*	
<i>Trimeria alutifolia</i> .....	(dioecious) males and females, greenish, very small	Nil	—	+	—	—	—	—	Low.
<i>Dioxyalis rhannonites</i> ....	(dioecious) females larger than males, but minute; cream	Females; sweet	—	—	‡Seeking nectar from females, pollen from males	—	—	—	Very low.
<i>Myrsine nclauquillives</i> ....	Cream; minute	Nil, or very faint	+	—	‡Seeking pollen	—	—	—	Medium.
<i>Faurea MacNaughtonii</i> ..	Faint pink to white; medium	Sweet	+	—	‡Seeking pollen, sometimes nectar	+	+	+	High.
<i>Vallesia capensis</i> .....	Pink, showy; medium	Very faint or nil	—	—	—	+	+	+	Medium.
<i>Gonioma kamassi</i> .....	Cream or very pale yellow; medium	Sweet; rich strong	++	—	—	+	+	+	Very low.
<i>Carlisa arbutina</i> .....	Waxy-white; medium	Sweet; rich	+	—	‡Seeking nectar	+	+	—	Low in Forests high under full light.
<i>Acoanthera venenata</i> ....	Waxy-white, pink-tinted; medium	Sweet, rich, sickly	+	—	‡Seeking nectar	+	+	—	Low.



Table II.—(Continued).

## FLOWERS : KNYNSA FOREST TREES—COLOUR, ODOUR, POLLINATION.

Species.	Colour and Size.	Odour.	AGENTS OF POLLINATION.							Degree of Efficient Pollination, †
			Self.	Wind.	Apis mellifica and A. castra.	Anthophora spp. and Nyctocopa spp.	Lepidoptera.	Nectariniidae and Promecops Caffr.*	Various.	
Calceodendron capense.....	Mauve; showy; medium	Very faint or nil	‡	—	‡Sucking pollen	‡	‡	Ants	Very low.	
Toddalia lanceolata.....	(Diaceous) greenish; minute	Nil	—	—	‡Sucking pollen from males and nectar from females	—	—	—	Low.	
Fagaria Davyl.....	(Diaceous) greenish-yellow; minute	Nil	—	—	‡Sucking pollen from males and nectar from females	—	—	Ants	Very low	
Pterocelastrus variabilis..	White; minute	Sweet; medium	‡	—	‡Sucking pollen (often nectar as well)	—	—	—	Low.	
Elaeodendron croceum...	White; minute	Faintly sweet	‡	—	‡Sucking pollen and nectar	—	—	—	Low.	
Elaeodendron capense....	White; minute	Faintly sweet	‡	—	‡Sucking pollen and nectar	—	—	—	Low.	
Elaeodendron Kraussianum	White; minute	Faintly sweet	‡	—	‡Sucking pollen and nectar	—	—	—	Very low.	
Celastrus acuminatus....	Straw or cream; minute	Sweet, rich	‡	—	‡Sucking pollen and nectar	—	—	—	Low.	

Table II.—(Continued).

## FLOWERS: KNYNSA FOREST TREES—COLOUR, ODOUR, POLLINATION.

Species.	Colour and Size.	Odour.	AGENTS OF POLLINATION.							Degree of Efficient Pollination.†
			Self.	Wind.	Apis mellifica and A. castra.	Anthophora spp. and Xylocopa spp.	Lepidoptera.	Nectariniidae and Promerops Caffr.*	Various.	
C. peduncularis.....	Straw or cream; minute	Sweet, rich	++	—	‡Seeking pollen and nectar	—	—	—	—	Low.
C. buxifolius.....	Straw or cream; minute	Sweet, rich	++	—	‡Seeking pollen and nectar	+	+	—	Ants	Medium.
Halleria lucida.....	White cream, brick-red, scarlet, or light-yellow; one colour per plant	Faint, sweet or nil	++	—	‡Seeking nectar	+	+	+	Ants Melolonthinae	Medium.
Electronia spp..... (P. obovata, P. Mundtii, and P. ventosa)	Cream to light straw; minute	Sweet, rich; strong	++	—	‡Seeking pollen, very rarely nectar	—	—	—	—	Low.
Burchellia capensis.....	Scarlet, medium	Nil	++	—	—	—	+	+	—	Medium.
Gardenia Rothmannia....	White, large	Sweet	++	—	‡Seeking pollen	—	+	+	—	Medium.
Royena lucida, R. pallens	Pale, dirty yellow	Sweet, tobacco-like medium	—	—	‡Seeking pollen from males, nectar from females	—	—	—	—	Low.
Euclea spp..... (E. macrophylla, E. racemosa and E. lanceolata)	White; minute	Sweet; medium	—	—	‡Seeking pollen from males, nectar from females	—	—	—	—	Low.

Table II.—(Continued.)

## FLOWERS : KNYNSA FOREST TREES—COLOUR, ODOUR, POLLINATION.

Species.	Colour and size.	Odour.	AGENTS OF POLLINATION.						Degree of Efficient Pollination. ‡
			Self.	Wind.	Apis mellifica and A. cauta.	Anthophora spp. and Xylocopa spp.	Lepidoptera.	Nectariniidae and Prometheops Caut. *	
<i>Sideroxylon lucm.</i> .....	Cream ; minute	Foetid ; strong	‡	—	‡Seeking pollen	—	—	—	Low.
<i>Rhus laevigata</i> .....	Straw ; minute	Faintly sweet or nil	‡	—	‡Seeking pollen	—	—	—	Low.
<i>Brachylaena nerifolia</i> ....	(Diocleous) white ; minute	Sweet	—	‡	‡Seeking pollen from males, nectar from females	—	—	Visit both sexes in search of insects	Medium.
<i>Tarchonanthus camphoratus</i>	(Diocleous) greenish-yellow ; minute	—	Nil	—	‡	—	—	—	Medium.
<i>Sparmannia africana</i> ....	White, showy, large	Nil	‡	—	‡Seeking pollen	‡	‡	—	Low.
<i>Tricholobus erinitis</i> and <i>T. ellipticus</i> (rare and local)	Yellow ; minute	Nil	—	‡	‡Occasionally for pollen	—	—	—	Low.
<i>Oelma arborea</i> .....	Yellow ; showy	Faint, sweet, or nil	‡	—	‡Seeking pollen	—	—	—	Low.
<i>O. atropurpurea</i> .....	Yellow ; showy	Faint, sweet, or nil	‡	—	‡Seeking pollen	—	—	—	Low.
<i>Lachnostylis capensis</i> ....	(Diocleous) greenish ; females larger, but minute	Nil	—	‡	—	—	—	—	Low.
<i>Ekebergia capensis</i> .....	Greenish-yellow ; minute	Faint, sweet, or foetid	‡	—	‡Seeking pollen	—	—	—	Very low.

Table II.—(Continued.)

## FLOWERS: KNYSNA FOREST TREES—COLOUR, ODOUR, POLLINATION.

Species.	Colour and size.	Odour.	AGENTS OF POLLINATION.						Degree of Efficient Pollination.†
			Self.	Wind.	Apis mellifica and A. castra.	Anthophora spp. and Xylocopa spp.	Lepidoptera.	Nectariniidae and Promerops Caffer.*	
<i>Ficus capensis</i> .....	Straw colour, within usual pear-shaped receptacle; minute	Nil	—	—	—	—	—	—	Very low.
<i>Celtis rhamniifolia</i> .....	Greenish-white; minute	Faint, sweet, or nil	‡	—	‡Seeking pollen from hermaphrodite and male flowers	—	—	—	Very low.
<i>Pittosporum viridiflorum</i> .	Greenish-white; minute	Sweet; medium	‡	—	‡Seeking pollen	—	—	—	Low.
<i>Rhamnus prinoides</i> .....	Yellow-green; minute	Faint or Nil	‡	—	‡Seeking pollen	—	—	—	Medium.
<i>Scutia Commersonii</i> .....	Greenish; minute	Faint or nil	‡	—	‡Seeking pollen	—	—	—	Low.

## NOTES TO TABLE II.

\* Nectariniidae—*Cinnyris* after L.  
C. *chalybeus* L.

† Degree of efficient pollination, i.e., of fertilization, based upon proportion of flowers that develop to form fruits.  
Very low..... 1-5 per cent. of total number of flowers produced are fertilized.  
Low..... 6-20 per cent. of total number of flowers produced are fertilized.  
Medium..... 21-40 per cent. of total number of flowers produced are fertilized.  
High..... 41-80 per cent. of total number of flowers produced are fertilized.  
‡ Denotes *pollinated by*.

Table III (A).

## NATURE OF THE FRUITS AND SEEDS—CONES AND CAPSULES.

Species.	Fruit.	Nature of the Fruit.	Size.	Number of Seeds.	Nature of Seeds.	Amount of Fruit Produced in Full Fruiting Seasons.
<i>Widdringtonia cupressoides</i>	A cone	Woody, valvate; 4-sealed, rounded; greenish-brown; glabrous	$\frac{3}{4}$ inch diameter	4-6	Winged.....	Medium.
<i>Platylophus trifoliatus</i>	A capsule	Imperforately deliscent, membranous, straw-coloured; 2-celled	$1\frac{1}{6} \times 1\frac{1}{10}$ inch	2; 2 others aborted	$1\frac{1}{15} \times 1\frac{1}{30}$ inch, russet, albuminous.....	Very large.
<i>Cumonia capensis</i>	A capsule	Deliscent, elongated, membranous, brown; 2-celled	$\frac{1}{4} \times \frac{1}{4}$ inch	30-50	Minute, straw-coloured, with slight marginal wings; albuminous; delicate	Very, very large.
<i>Nuxia floribunda</i>	A capsule	Deliscent, septicidal; membranous, straw-coloured; 2-celled	$1\frac{1}{6} \times 1\frac{1}{8}$ inch	Numerous	Minute, albuminous; delicate.....	Very, very large.
<i>Chilanthus arbores</i>	A capsule	Deliscent, septicidal; membranous, straw-coloured, scurfy; 4-valved	$1\frac{1}{12} \times 1\frac{1}{15}$ inch	5-15	Minute, elongated, slightly winged in some cases; albuminous; delicate	Very large.
<i>Krugelaria africana</i>	A capsule	Deliscent into 3-5 valves; leathery, greenish-yellow, pubescent, and tubercled	$\frac{3}{4}$ inch diameter	15-20	Red-coated; black, shiny within the coat; hard; albuminous	Large.
<i>Trimeria alufolia</i>	A capsule	3-valved, obovate, leathery.....	$1\frac{1}{7} \times 1\frac{1}{16}$ inch	1-3	Minute, pitted, black, albuminous.....	Medium.
<i>Gonolua Kabassi</i>	2 divergent foliaceous, or mericarps	Leathery or semi-woody, oblong, straight, or curved	$1\frac{1}{2} \times 2 \times \frac{1}{2}$ inches	Numerous	Both ends large-winged ( $1\frac{1}{2}$ inch); variable in size and shape; usually flat; albuminous	Small.
<i>Calodendron capense</i>	A capsule	Dry, woody, angled, tubercled, deliscent septically	$1\frac{1}{2}$ inches diameter	4-5	$\frac{1}{2}$ inch diameter, angled, hard, black, shiny, exalbuminous	Very small.
<i>Fagara Davayi</i>	A capsule	Deliscent into 2 valves, dry, leathery, gland-dotted, acrid	$1\frac{1}{8} \times 1\frac{1}{16}$ inch	1	Hard, shiny, black, albuminous.....	Very small.

Table III (A)—(Continued).

## NATURE OF THE FRUITS AND SEEDS—CONES AND CAPSULES.

Species.	Fruit.	Nature of the Fruit.	Size.	Number of Seeds.	Nature of Seeds.	Amount of Fruit Produced in Full Fruiting Seasons.
<i>Pterocarpus variabilis</i>	A capsule	Semi-succulent, woody, 3-celled, winged, dehiscent	$\frac{1}{4}$ – $\frac{1}{2}$ inch diameter	1–3	Hard, shiny, black, within yellow aril, albuminous	Large.
<i>Celastrus acuminatus</i>	A capsule	2-lobed, 2-valved, leathery.....	$\frac{1}{2} \times \frac{1}{4}$ inch	1, rarely 2	Hard, shiny, black, within yellow aril, albuminous	Large.
<i>C. peduncularis</i>	A capsule	Obovate, 2-valved, leathery.....	$\frac{1}{2} \times \frac{1}{4}$ inch	1	Hard, shiny, black, within yellow aril, albuminous	Medium.
<i>C. buxifolius</i>	A capsule	3-lobed, 3-valved, leathery to semi-woody.....	$\frac{1}{2} \times \frac{1}{4}$ inch	2–3	Hard, shiny, black, within yellow aril, albuminous	Large.
<i>Sparmannia africana</i>	A capsule	Ecliptate, dehiscent loculicidally; 4–5-celled; leathery, straw-colour	$\frac{1}{2}$ – $\frac{3}{4}$ inch diameter	Numerous	Minute, albuminous.....	Large.
<i>Trichocladus crinitus</i>	A capsule	2-celled, woody, opening violently.....	$1/6 \times 1/10$ inch	2	Cream or yellow, hard, albuminous.....	Large.
<i>T. ellipticus</i> (rare & local)	A capsule	2-celled, woody, opening violently.....	$1/6 \times 1/10$ inch	—	Cream or yellow, hard, albuminous.....	Medium.
<i>Lachnostylis capensis</i>	A capsule	Dehiscent into 6 valves; leathery, greenish to straw-colour	$\frac{1}{2}$ – $\frac{3}{4}$ inch diameter	3–6	Black, hard, angular, albumen scanty.....	Large.
<i>Pittosporum viridiflorum</i>	A capsule	2-valved, leathery.....	$\frac{1}{2} \times \frac{1}{4}$ inch	6–8	Reniforme, albuminous, in viscid, transparent resin	Small.
<i>Virgilia capensis</i>	A legume	Dehiscent into 2 valves; membranous, straw-coloured	$1\frac{1}{2}$ –3 $\times$ $\frac{1}{4}$ inches	—	Very hard, black, exalbuminous.....	Large.

## NATURE OF THE FRUITS AND SEEDS—BERRIES AND DRUPES.

Tabl III (B).

Species.	Fruit.	Size.	Description of the Fruits and Seeds.				Amount of Fruit Produced in Full Fruiting Seasons.
			Nature of the Pericarp or Covering.	Colour of the Pericarp or Covering.	Flavour of the Pericarp or Covering.	Number of Seeds (or Endocarps).	Nature of the Seeds (or Endocarps).
<i>Olea laurifolia</i> .....	Drupe, ellipsoid	$\frac{3}{4}$ —1 $\times$ $\frac{1}{2}$ inches	Succulent, thick; edible (*)	Dark purple	Bitter-sweet	1	Very hard, bony endocarp with 1 albuminous seed
<i>O. capensis</i> .....	Drupe, ellipsoid	$\frac{1}{2}$ diam.	Succulent, moderately thick; edible	Dark purple	Bitter-sweet	1	Very hard, bony endocarp with 1 albuminous seed
<i>O. foveolata</i> .....	Drupe, ellipsoid	$\frac{1}{2} \times \frac{1}{4}$	Succulent, moderately thick; edible	Dark purple	Bitter-sweet	1	Very hard, bony endocarp with 1 albuminous seed
<i>Ocotea bullata</i> .....	Drupe, ellipsoid	$\frac{1}{2} \times \frac{1}{4}$	Succulent, moderately thick.	Dark purple	Bitter; of Laminin	1	Moderately hard, chitinous endocarp with 1 large, exalbuminous seed
<i>Apodytes dimidiata</i> ....	Baccate drupe with a red callous heel	$\frac{1}{2} \times \frac{1}{4}$	At first very slightly succulent, later, dry; thin	Black; heel red, later grey	Bitter	1	Seed reniforme, with a delicate coat; rich in black albumen
<i>Cassinopsis capensis</i> ....	Drupe, compressed	$\frac{1}{2} \times \frac{1}{4}$	At first semi-succulent, later, dry; thin	Black	Bitter	1	Hard-shelled endocarp with 1 compressed albuminous seed
<i>Curtisia faginea</i> .....	Drupe, globose	$\frac{1}{2}$ — $\frac{3}{4}$ diam.	Succulent, later papery; thick	Cream or white, or pink-tinted	Bitter	1 endocarp with 1-4 seeds	Endocarp hard, chitinous, seeds with membranous covers; albuminous
<i>Olinia cymosa</i> .....	Drupe, globose	$\frac{1}{2}$ — $\frac{3}{4}$ diam.	Succulent, thick, remaining fresh over 6 months; edible	Scarlet	Sweet, almond-like	1 endocarp with 1-5 seeds, in viable condition	Endocarp, chitinous, reticulated; seeds in brown membranous, exalbuminous
<i>Ilex mitis</i> .....	Drupe, globose	$\frac{1}{2}$ diam.	Succulent, thin.....	Scarlet	Bitter	4-6 pyrenes	Seeds, hard 3-sided, albuminous
<i>Sceloparia Munzii</i> .....	Berry, elliptic	$\frac{1}{2} \times \frac{1}{4}$	Succulent, moderately thick.	Pink	Sweet; edible	1, rarely 2-seeded	Elongated, albuminous.....
<i>S. Zeyheri</i> .....	Berry, elliptic	$\frac{1}{2} \times \frac{1}{4}$	Succulent, moderately thick.	Pink	Sweet; edible	1, 2, or 3 seeded	Elongated albuminous.....
<i>Dovyalis rhamnoides</i> ...	Berry, elliptic	$\frac{1}{2} \times \frac{1}{4}$	Succulent, moderately thick.	Yellow	Sweet or acid; edible	1-2 seeded	Albuminous.....

Table III (b).—Continued).

## NATURE OF THE FRUITS AND SEEDS—BERRIES AND DRUPIES.

Species.	Fruit.	Size.	Description of the Fruits and Seeds.				Amount of Fruit Produced in Full Fruiting Seasons.
			Nature of the Pericarp or Covering.	Colour of the Pericarp or Covering.	Flavour of the Pericarp or Covering.	Number of Seeds (or Endocarps).	
<i>Mycrsine melanophloeos.</i>	Drupe, globose.	1/2-3/4 diam.	Succulent, moderately thick.	Very dark purple.	Bitter	1 endocarp with 1 seed	Very large.
<i>Carissa arduina</i> .....	Berry, elliptic	1/2-1 x 1/4	Succulent, moderately thick; with latex; edible	Scarlet or pink	Sweet	1, rarely 2	Small.
<i>Acokanthera venenata</i> ..	Berry, ovoid	1/2 x 1/2	Succulent, thick, with latex. Highly poisonous	Scarlet	? said to be sweet	1 by abortion; 2 rarely	Large.
<i>Toddalia lanceolata</i> ....	Berry, globose	1/2-1 diam.	Leathery, dry, moderately thick	Green to black	Acrid	4	Large.
<i>Elaeagnodendron croceum</i> .	Drupe, ovoid or globose	1/2 x 1/2	Succulent, thick.....	Cream or white	Bitter	1 endocarp with 1 (rarely 2-3) seeds	Medium.
<i>E. capense</i> .....	Drupe, ellipsoid	1 x 1/2	Succulent, thick.....	Cream or white	Bitter	1 endocarp with 1 (rarely 2-3) seeds	Medium.
<i>E. kraussianum</i> .....	Berry, globose	1/2-3/4 diam.	Leathery, moderately thick..	Black	Bitter	1-2	Small.
<i>Halleria lucida</i> .....	Berry, globose	3/4-1 diam.	Fleshy, thick; edible.....	Black	Bitter-sweet, not unpleasant	Numerous	Very large.
<i>Electronia obovata</i> ....	Berry, globose	1/2 diam.	Soup-succulent; moderately thick	Black	Bitter	2 pyrenes each 1 seeded	Medium.
<i>P. Mundtii</i> .....	Berry, didymous	3/4 x 1/2	Soup-succulent; moderately thick	Black	Sweetish; edible	1 or 2 pyrenes	Medium.
<i>P. ventosa</i> .....	Berry, didymous, pear-shape	1 x 1/2	Soup-succulent; moderately thick	Black	Sweetish; edible	1 or 2 pyrenes	Medium.
<i>Burchellia capensis</i> ....	Berry with long erect calyx-lobes	Without calyx-lobes, 1/2 x 1/2	Leathery, thick.....	Green to brown	Bitter	Numerous	Large.



Species.	Fruit.	Size.	Description of the Fruits and Seeds.				Amount of Fruit Produced in Full Fruiting Seasons.
			Nature of the Pericarp or Covering.	Colour of the Pericarp or Covering.	Flavour of the Pericarp or Covering.	Number of Seeds (or Endocarps).	
<i>Gardenia Rothmannia</i> ...	Large ovate leathery berry; 1-celled	Inches. $2 \times 1$	Leathery to woody, costate; thick, with abundant pith	Green, later black	Bitter	Numerous	Medium.
<i>Boyena lucida</i> .....	Berry, with prominent accrescent calyx	$\frac{1}{2}$ diam.	Semi-succulent, thick.....	Green later brown	Bitter	2-4	Large.
<i>Euclea macrophylla</i> ...	Apiculate berry	1/5 diam.	Semi - succulent, minutely glandular; moderately thick	Black	Sweet; edible	1	Small.
<i>E. racemosa</i> .....	Berry	1/5 diam.	Semi-succulent moderately thick	Black	Sweet; edible	1	Small.
<i>E. laurocolata</i> .....	Berry	$\frac{3}{4}$ diam.	Semi-succulent, moderately thick	Black	Sweet; edible	1	Small.
<i>Sideroxylon inerme</i> ...	Drupe	$\frac{1}{4}$ diam.	Succulent, with abundant viscid latex; thick	Black	Sweet; edible	1 (endocarp) by abortion, hard	Large.
<i>Rhus havigata</i> .....	Drupe	$\frac{1}{4}$ diam.	Semi-succulent, moderately thick; sometimes leathery	Reddish	Sweetish; edible	1 endocarp	Medium.
<i>Occhua arborea</i> .....	3-6 drupes seated on a fleshy torus	Drupes $\frac{1}{4} - \frac{3}{4} \times \frac{1}{4}$	Drupes; succulent, moderately thick pericarps	Black	Bitter	1 endocarp	Very small.
<i>O. atropurpurea</i> .....	3-6 drupes seated on a fleshy torus	Drupes $\frac{1}{4} - \frac{3}{4} \times \frac{1}{4}$	Drupes; succulent, moderately thick pericarps	Black	Bitter	1 endocarp	Very small.
<i>Ekobergia capensis</i> ...	Berry	$\frac{1}{4} - \frac{3}{4}$ diam.	Succulent, later leathery; thick	Scarlet	Sweet; edible	2-5 pyrenes	Large.
<i>Celtis thamniafolia</i> ...	Drupe, ovoid	$\frac{1}{4}$ diam.	Slightly succulent; thin....	Red	Bitter	1	Small.
<i>Rhamnus prinoides</i> ...	Berry	$\frac{1}{4}$ diam.	Succulent, moderately thick.	Black	Bitter	1	Very large.
<i>Scutia Commersonii</i> ...	Berry	$\frac{1}{4} - \frac{3}{4}$ diam.	Succulent, moderately thick.	Black	Dry, sweet, edible	3	Medium.

Table III (c).

## NATURE OF THE FRUITS AND SEEDS—MISCELLANEOUS.

Species.	Fruit.	Description of the Fruit.	Number of Seeds.	Nature of the Seeds.	Amount of Fruit Produced in Full Fruiting Seasons.
<i>Faurea MacNaughtonii</i> .....	A long-villous nut with a persistent style	$\frac{1}{2} \times \frac{1}{4}$ inch; brown, leathery, with abundant hairs	1	Yellow, fleshy, ex-albuminous	Very, very large.
<i>Brachylaena nerifolia</i> .....	An achene.....	Minute, glandular, with 2 rows of bristly pappus	1	Exalbuminous....	Very, very large.
<i>Tarchonanthus camphoratus</i> .....	An achene.....	Minute, woolly, without pappus.....	1	Exalbuminous....	Very large.
<i>Ficus capensis</i> .....	Numerous minute achenes in a fleshy receptacle, or "fig"	Fig: $\frac{1}{2} \times 1 \times \frac{1}{4}$ inch; achenes: $1/20$ inch; fig: fleshy, sweet, edible. Achenes: hard, membranous, perianth persistent.	1 1	Albumen scanty..	Figs: small. Achenes: very large.
<i>Podocarpus elongata</i> L'Herit.....	Arillate seed (a podocarpium) without a fleshy receptacle	Globose fruit $\frac{1}{2} \times \frac{3}{4}$ inch diameter, rich yellow; outer layer fleshy, inner, very hard, chubbous, tubercled; edible	1	Rich in endosperm	Large.
<i>P. Thunbergii</i> , Hook.....	Arillate seed (a podocarpium) possessing a succulent, well-developed receptacle	Seed: globose, $\frac{2}{3} \times \frac{3}{4}$ inch diameter, greenish-purple; outer layer fleshy, resinous; inner layer chubbous, thin; edible. Receptacle: 2-lobed, cherry-red, succulent, $\frac{1}{2} \times \frac{3}{4}$ inch; edible	1	Rich in endosperm	Very large.

NOTE TO TABLE 3 (b) AND 3 (c).

"Edible" . . . is sought by man; fruits edible for mammals and birds but not for man, are not described as "edible."

Table IV.

## AGENTS OF DISPERSAL.

Wind.	Water.	Birds.	Feral Mammals.	Man.	Various.
Seeds with large membranous wings. (Inefficient as means of dispersal.) Wildfringetia cupressoides. Gouima Kanassii.	Heavy rains, streams and rivers, rarely the sea. Seeds. Viridia capensis (day and night) Calodendron capensis (day sea) Lachnostylis capensis (day sea)	Principally Doves (Columba aquatica, Turtur capensis, Chalcophaps indica, Haplophys laticollis, "Loric", "Turnicoides corollatus", "Coronoides corollatus", "Lophoceros melanoleucus", "Apidras naris", "Red-winged Starling"). Endocarpis often ground to pieces by Doves.) Podocarpus Thunbergii. P. elongata. Olea laurifolia (75 removed from 1 dove). O. capensis (over 100 removed from 1 dove). O. tinoyi (from 1 dove). Blacodendron croceum. E. capensis. Olea cynosa. Curatla lagenea. Sideroxylon guineae. Oeclea bullata. Ekebergia capensis.	Seeds or Endocarps passed out in the fates. Elephant (vide Phillips, 1925 : 2). Scutia Commersonii. Viridia capensis. Blacodendron croceum. E. capensis. Olea laurifolia. O. tinoyata. Myrsine melanophloeos. Olea cynosa. Podocarpus elongata. L. Herit.	Edible Fruits. Halleria lucida. Olea cynosa. Olea laurifolia. O. capensis. Scutia Commersonii. Carissa arbuta. Sideroxylon guineae. Scelopora Zeyheri. S. Mundtii. Rhus capensis. Podocarpus elongata. L. Herit. P. Thunbergii, Hook. (taken for sake of the succulent receptacle). Plectronia Mundtii. P. ventosa. Euclea spp.	Feet and Feathers of Birds and Feet of Mammals. Cuculia capensis. Chilanthus arboreus. Xuxia floribunda. Domesticated Birds. Principally— Olea spp. Olea cynosa. Podocarpus Thunbergii, Hook. Dogs. Olea laurifolia drupes are relished, endocarps are passed out. Olea cynosa, sometimes taken. Unpalatable Fruits not taken by Birds or Mammals. Apodytes dimidiata. Passiflora capensis. Pagarat Davyl. Toddala laucolata. Pittosporum viridiflorum Poisonous Fruit, not taken by Birds and Mammals. Acokanthera venenata.
Minute seeds with much-reduced, membranous wings. (Inefficient as means of dispersal.) Cuculia capensis.	Endocarps. Olea laurifolia. O. capensis. P. elongata. Blacodendron croceum. E. capensis. Olea cynosa. Sideroxylon guineae (day sea).	By the shore birds and by smaller ones, principally Colinus stratus, ("Monobird"), Crithalus laticollis, "Geel kattekreun", "Estrilda astrilda", Zosterops capensis, ("Cape White-eye"). Doygalis rhainoides. Scelopora Zeyheri. S. Mundtii. Kigelia africana. Carissa arbuta. Rhamnus prinoides. Scutia Commersonii.	Wild Pig (Palanchoeris chloropithecus). Podocarpus elongata. L. Herit. Blacodendron croceum. E. capensis. Olea laurifolia. O. tinoyata. O. capensis. Myrsine melanophloeos. Olea cynosa. Viridia capensis. Sideroxylon guineae. Rhus laevigata. Rhamnus prinoides. Plectronia obovata. P. Mundtii. P. ventosa. Ekebergia capensis. Baboon and Monkey (Chloropithecus parvulus and Cercopithecus pagellus). All above listed except Viridia Giardena Rothmannia.		
Light membranous capsules not readily deliquescent. (Very inefficient as means of dispersal.) Platylophus trifoliatus.	Podocarpus. Podocarpus Thunbergii, Hook. P. elongata. L. Herit (day sea)				
Minute seeds with no wings. (Inefficient for wind-dispersal.) Xuxia floribunda. Chilanthus arboreus. Sparmannia africana.	Pesky Berry. Halleria lucida.				
Minute achenes with scant pappus. (Inefficient as means of dispersal.) Brachylaena verticillata.					
Minute achenes with woolly covering. (Inefficient as means of dispersal.) Tarchonanthus canphoratus.					

Table IV.--(Continued).

## AGENTS OF DISPERSAL.

Wind.	Water.	Birds.	Feral Mammals.	Man.	Various.
<p><i>Dioscorevillosus</i> nut. (Very ineffectual for wind-dispersal). Fauria MacNaughtonii.</p>		<p>Halleria lucida. Ilex mitis. Olea arboresc. O. acuminata. Rhus acutifolia. Pterocladus variabilis (seeds). Celastrus acuminatus (seeds). C. peduncularis (seeds). Elaeodendron Kraussianum. Celtis rhombifolia. Euclea capensis (seed). Euclea spp. Electronia ovata. P. Mundii. P. Ventosa. Myrsine melanophloeos. Trimeria abutilifolia. The endocarps of seeds are either voided in the droppings or regurgitated.</p>	<p><i>Bushbuck</i>. (<i>Tragelaphus sylvaticus</i>), (<i>Griffithus</i>), (<i>Pseudotragelaphus</i>), (<i>Blaschke</i>) (<i>Cephalophus monticola</i>). P. foveatus Thunbergii. Halleria lucida (seeds). Virginia capensis (seeds rarely). <i>Wild Cat</i> (<i>Felis affra</i>). <i>Olea laurifolia</i>. O. capensis. O. toxiolara. Olinia cynosa. Drupes taken in times of poor hunting.</p> <p><i>Frail Bat</i> (<i>Rousettus col. larisi</i>). <i>Olea</i> spp. <i>Olea</i>. <i>Dovyalis</i>. <i>Scutia</i>. <i>Podocarpus</i> spp.</p>		

Table V.

## PERIOD REQUIRED FOR GERMINATION—GERMINATIVE CAPACITY—AGENTS OF MORTALITY IN FRUITS AND SEEDS.

Species.	Average period required for germination: normal forest conditions.	Germinative Capacity.*	Principal Agents of Mortality in Fruits and Seeds attaining maturity.	Remarks re Fruits and Seeds not attaining maturity.
<i>Podocarpus L'Herit</i>	6 (rarely)–30 months; generally about 12; removal of succulent covering shortens period	50–80 per cent.....	<i>Ceratitis capitata</i> larvae sometimes destroy embryo; Lepidopterous larvae often destroy embryo. Destroyed by wild pig and bats.	Wind-blown; knocked off by birds and bats.
<i>P. Thunbergii</i> Hook.....	2–4 months; generally 2½.....	Variable, 20–80 per cent, but usually 50–60 per cent.	<i>Ceratitis capitata</i> larvae damage a fair number of embryos; <i>Carpodella aberata</i> Fr. often destroys 20–50 per cent. of the embryos. Lepidopterous larvae destroy a fair number of embryos. Destroyed by wild pig and bats, also by doves.	<i>Carpodella aberata</i> prevents development of large proportion of young fruits; others are dislodged by wind, birds, and bats
<i>Widdringtonia cupressoides</i>	1½–3 weeks.....	60–70 per cent.....	Some seeds are very poorly developed, being small and light, these do not germinate; small Curculionidae destroy others	Practically all seeds attain maturity.
<i>Olea laurifolia</i> .....	6–18 months; usually 12; removal of pericarps appreciably decreases the period. Endocarps passed through wild pig and bushdove germinate in 4–6 months	50–80 per cent.....	<i>Ceratitis capitata</i> , <i>Manomyia nudiseta</i> , and <i>Afradacus biguttatus</i> destroy many embryos. A Lepidopterous larva destroys a few. Wild pig, bushdove, destroy many endocarps	Approximately 75 per cent. of the fruit crop of each tree falls prematurely owing to (1) fungus (Hysteriaceae) attacking fruit-stalks; (2) disturbance caused by Bushdoves and Turacus; (3), heavy wind.
<i>Olea capensis</i> .....	6–36 months; usually 9–12; removal of the pericarps appreciably decreases the period. Endocarps passed through wild pig and bushdove germinate in 4–6 months	40–60 per cent.....	<i>Ceratitis capitata</i> destroys many embryos. Wild pig and bushdove destroy many endocarps	Approximately 50 per cent. of the fruit crop of each tree falls prematurely owing to (1) disturbance caused by bushdoves and Turacus (2) heavy wind.
<i>Olea tovelolata</i> .....	6–12 months; remarks as for <i>Olea capensis</i>	50–60 per cent.....	<i>Ceratitis capitata</i> , <i>Manomyia nudiseta</i> , <i>Afradacus biguttatus</i> , destroy large numbers of embryos. Wild pig and bushdoves destroy many endocarps	do. do.

Table V.—(Continued).  
PERIOD REQUIRED FOR GERMINATION—GERMINATIVE CAPACITY—AGENTS OF MORTALITY IN FRUITS AND SEEDS.

Species.	Average period required for germination; normal forest conditions.	Germinative Capacity.*	Principal Agents of Mortality in Fruits and Seeds attaining maturity.	Remarks <i>re</i> Fruits and Seeds, not attaining maturity.
<i>Ocotea bullata</i> .....	1-2 months; bird-voided endocarps usually require 3-4 weeks	0.01-1 per cent....	<i>Ceratitis capitata</i> and the larva of a small moth destroy large numbers of the embryos. The bulk of the destruction, however, is due to <i>Pestalotia n. sp.</i> , <i>Fusicium spp.</i> attack fallen, mature fruits. Bats and wild pig destroy many endocarps	Wind, birds, and bats knock down over 5 per cent. of the crop of each tree, before its maturity; these fallen fruits are attacked by insects, fungi, and destroyed by wild pig.
<i>Apodytes dimidiata</i> .....	14-3 months.....	Very variable; 50-70 per cent. in some crops, only 10-20 per cent. in others	Lepidopterous larva destroys many embryos; <i>Ceratitis capitata</i> sometimes destroys a fair number. Small Curculionidae destroy others	Many fruits fall prematurely on account of severe winds.
<i>Cassinopsis capensis</i> .....	3-4 months.....	70-80 per cent....	A few fruits are destroyed by various insects	Very few fruits fall prematurely.
<i>Curtisia faginea</i> .....	6-12 months; removal of the succulent pericarp lessens period	40-50 per cent....	Dipterous and Lepidopterous larvae destroy many embryos; many seeds decay before loony endocarp allows of their escape. Bats, wild pig and bushdoves destroy many endocarps	Many fruits are very poorly developed owing to gall-forming organism in the flowers.
<i>Platylophus trifoliatus</i> ...	1-3 months.....	2-4 per cent.	Capsules do not allow of ready escape of the seeds, which may thus decay before capsule walls have broken down <i>Zosterops capensis</i> ("Cape White-eye") destroys numbers of the seeds. Fallen mature capsules are destroyed in considerable numbers by wild pig.	The overwhelming majority of seeds does not develop to maturity despite the formation of large, healthy capsules.
<i>Cononia capensis</i> .....	1-3 months.....	2-5 per cent.....	The larger proportion of the capsules fall in moist or fern-clad sites, and into water, they thus readily decay. Millions of seed fall upon leaning tree-trunks, tree-fern tops, mossy stones, etc., and either decay before germination, or produce 1-several day-lived seedlings only. <i>Zosterops capensis</i> and <i>Extrilata astrida</i> ("Sweet") destroy thousands of seeds.	Whole fruit-bearing spikes are blown by wind ere they are mature; many capsules are destroyed by birds.
<i>Nuxia floribunda</i> .....	14-3 months.....	Less than 1 per cent.	Millions of the seeds share the same fate as those of <i>Cononia</i> as above described. A <i>Fusicium sp.</i> causes decay in large numbers of fallen fruits. Large numbers are under-developed, with small embryos.	Fruiting panicles are blown by the thousand, ere the fruits are mature.

Table V.—(Continued).

## PERIOD REQUIRED FOR GERMINATION—GERMINATIVE CAPACITY—AGENTS OF MORTALITY IN FRUITS AND SEEDS.

Species.	Average period required for germination: normal forest conditions.	Germinative Capacity.	Principal Agents of Mortality in Fruits and Seeds attaining maturity.	Remarks re Fruits and Seeds not attaining maturity.
<i>Chilanthus arboreus</i> .....	1½-2 months.....	Less than ½ per cent.	Millions fall upon ground unsuitable for germination, and decay. Coleoptera destroy large numbers of the seeds, and various fungi claim many others.	Fruiting panicles are blown by the thousand, ere the fruits are mature.
<i>Olinia cymosa</i> .....	Varies according to locality: may lie dormant for 24-40 months, or may germinate within 12-18 months	8-12 per cent.....	Hard, chitinous endocarp takes many months to decay, the small white, delicate embryos not supplied with food-reserves, and often decays ere it is able to put out its radicle. Large numbers of under-developed embryos occur. <i>Ceratitis capitata</i> destroys a small number of seeds.	Wind, birds, bats dislodge thousands of immature fruits.
<i>Ilex capensis</i> .....	2-4 months.....	40-60 per cent.....	Dipterous and Lepidopterous larvae destroy a number of seeds. Wild pigs destroy many fallen fruits.	do. do.
<i>Kiggelaria africana</i> .....	1½-3 months.....	70-80 per cent.....	Dipterous larvae destroy a number of seeds.	do. do.
<i>Scelopora Mundtii</i> .....	2-3 months.....	40-50 per cent.....	Dipterous and Lepidopterous larvae destroy large numbers of seeds. Wild pigs destroy many fallen fruit.	do. do.
<i>S. Zeyheri</i> .....	2-3 months.....	50-60 per cent.....	do. do.	do. do.
<i>Trimeria albigolia</i> .....	1½-2 months.....	60-70 per cent.....	Dipterous larvae do some harm.....	The compact fruiting spikes are blown in large numbers ere mature.
<i>Dovyalis rhannoides</i> .....	2-3 months.....	70-80 per cent.....	<i>Ceratitis capitata</i> accounts for some of the embryos	Wind, birds, bats cause premature fall of many fruits.
<i>Myrsine melanophloeos</i> ....	2-4 months.....	40-60 per cent.....	<i>Corynelia fraticola</i> destroys many fruits: <i>Ceratitis capitata</i> does some damage	<i>Corynelia</i> inhibits the development of large numbers of young fruits
<i>Faurea MacNanghrounii</i> ...	1½-3 months.....	½-1 per cent.....	No diseases known: seeds very poorly developed despite size of the fruits	Large numbers of nuts fall prematurely owing to strong winds
<i>Virgilia capensis</i> .....	unless stimulated by heat or bruised, the seeds remain dormant for many years (vide Phillips, J. F., 1926 (4)): on stimulation, germination takes place within 7-21 days	99-100 per cent....	No diseases known.....	A small number of legumes is blown by wind ere maturity.

Table V.—(Continued).

PERIOD REQUIRED FOR GERMINATION—GERMINATIVE CAPACITY—AGENTS OF MORTALITY IN FRUITS AND SEEDS.

Species.	Average period required for germination: normal forest conditions.	Germinative Capacity.*	Principal Agents of Mortality in Fruits and Seeds attaining maturity.	Remarks re Fruits and Seeds not attaining maturity.
<i>Gonoma Kamassi</i> .....	1-2 months.....	30-40 per cent.....	Curculionidae destroy some seeds; many seeds very poorly developed. Seeds readily destroyed by water.	Follicles often fall prematurely.
<i>Carissa arduina</i> .....	11-24 months.....	20-30 per cent.....	<i>Cratichneumon capitata</i> and other Dipterous larvae destroy many seeds	Many fruits fall prematurely.
<i>Acothanthura venenata</i> ...	4-5 months.....	80-90 per cent.....	No diseases known; some seeds underdeveloped	A few fruits fall prematurely.
<i>Calodendron capense</i> ....	8-16 months.....	80-90 per cent.....	No diseases known; some seeds underdeveloped	A few fall prematurely.
<i>Toddalia lanceolata</i> .....	3-4 months.....	70-80 per cent.....	No diseases known. Some seeds are poorly developed	Large numbers are blown by wind before maturity.
<i>Fagara Davidi</i> .....	3-4 months.....	60-70 per cent.....	Large numbers of poorly developed seeds; no diseases known	do. do.
<i>Pterocelastrus variabilis</i> ...	2½-3 months.....	60-70 per cent.....	Dipterous larvae destroy fair numbers of seeds; fallen seeds sometimes attacked by <i>Fusarium</i> sp. which sets up decay	A few fruits fall prematurely.
<i>Elaeodendron croceum</i> ...	12-30 months; removal of the pericarp appreciably decreases the period	70-80 per cent.....	Dipterous larvae destroy a small number of seeds; Lepidopterous larva chews a few; endocarps that remain on soil for a long period are subject to decay through various fungi.	Birds and bats dislodge a fair number of drupes.
<i>E. capense</i> .....	do. do.	do. do.	do. do.	do. do.
<i>E. Kraussianum</i> .....	4-5 months.....	50-70 per cent.....	Many seeds are underdeveloped; Dipterous and Lepidopterous larvae destroy fair numbers	Only a few fruit fall prematurely
<i>Celastrus acuminatus</i> ....	2½-3½ months.....	50-60 per cent.....	do. do.	Many fall prematurely.
<i>C. pedunculatus</i> .....	3-4 months.....	60-70 per cent.....	do. do.	do. do.
<i>C. buxifolius</i> .....	3-4 months.....	70-80 per cent.....	A small number is underdeveloped; a small number is destroyed by larvae of Diptera	do. do.
<i>Halleria incida</i> .....	2-3 months.....	85-90 per cent.....	No diseases of seed known. A few seeds are underdeveloped	The larger portion of each crop falls prematurely



Table V.—(Continued).  
PERIOD REQUIRED FOR GERMINATION—GERMINATIVE CAPACITY—AGENTS OF MORTALITY IN FRUITS AND SEEDS.

Species.	Average period required for germination; normal forest conditions.	Germinative Capacity.*	Principal Agents of Mortality in Fruits and Seeds attaining maturity.	Remarks re Fruits and Seeds, not attaining maturity.
<i>Platonia obovata</i> .....	2½-3 months.....	50-60 per cent.....	Dipterous larvae destroy many seeds.....	Many fall prematurely.
<i>P. Mundtii</i> .....	2-3 months.....	40-50 per cent.....	Dipterous larvae destroy many seeds. Wild pig and doves destroy many	do. do.
<i>P. ventosa</i> .....	2-3 months.....	30-50 per cent.....	do. do.	do. do.
<i>Burchellia capensis</i> .....	3-4 months, if seeds are removed from tough-coated berry; 6-8 months if berry be left undisturbed	40-50 per cent.....	Large numbers of the seeds are under-developed	Very few fruits fall prematurely.
<i>Gardenia Rotumanica</i> .....	3½-4½ months, if seeds are removed from pithy fruit; 9-12 months if fruit be left undisturbed.	70-80 per cent.....	Many seeds are attacked by Mould-fungi during drying-out process of the large fruit. Curculionidae destroy some seeds. A few seeds are destroyed by baboons which steal the fruits	Baboons dislodge and destroy many green fruits.
<i>Royena lucida</i> .....	3-4 months.....	35-45 per cent.....	<i>Ceratitis capitata</i> destroys large proportion of fruits	Wind and baboons dislodge many fruits.
<i>Euclea macrophylla</i> .....	3½-4½ months.....	50-60 per cent.....	Many seeds are under-developed; Dipterous larvae destroy many	A few fall prematurely.
<i>E. racemosa</i> .....		40-50 per cent.....	do. do.	
<i>E. lanceolata</i> .....		40-50 per cent.....	do. do.	
<i>Sodiroxylon lucine</i> .....	4-6 months.....	75-80 per cent.....	<i>Ceratitis capitata</i> destroys a large proportion Wild pigs destroy many fallen fruits	Birds dislodge large numbers of fruits.
<i>Rhus laevigata</i> .....	3-4 months.....	40-50 per cent.....	Dipterous larvae destroy a large number.	Birds and wind dislodge large numbers of fruit.
<i>Brachylaena nerifolia</i> .....	1-1½ months.....	10-20 per cent.....	A large proportion of embryos is under-developed; water acts detrimentally upon others; the glandular achenes are destroyed by moulds, by Dipterous larvae and by Curculionidae.	The larger proportion of achenes is blown prematurely.
<i>Tarchonanthus camphoratus</i>	2-3 months; if woody covering remains in place, the period may be 6-9 months—until such covering has decayed	20-30 per cent.....	A large number of achenes do not escape from woody coverings ere the embryos have perished; Curculionidae, Lepidopterous larvae, and moulds destroy large numbers of achenes.	A large number is blown prematurely.
<i>Sparmannia africana</i> .....	3-5 months.....	40-50 per cent.....	A large number is under-developed; Fusarium spp. and moulds destroy others. Water assists in rapid decay	A large number is blown prematurely.

Table V.—(Continued).  
PERIOD REQUIRED FOR GERMINATION—GERMINATIVE CAPACITY—AGENTS OF MORTALITY IN FRUITS AND SEEDS.

Species.	Average period required for germination: normal forest conditions.	Germinative Capacity.*	Principal Agents of Mortality in Fruits and Seeds attaining maturity.	Remarks re Fruits and Seeds not attaining maturity.
<i>Trichodadus crinitus</i> ..... T. ellipticus (rare and local)	2½-3½ months..... do.	80-90 per cent..... 60-70 per cent.....	Curculionidae destroy a few..... do.	A few seeds fall ere maturity.
<i>Ochra arborea</i> .....	3-4 months.....	30-40 per cent.....	<i>Ceratitis capitata</i> , other Dipterous larvae, Lepidopterous larvae, and Curculionidae do much damage	A large number falls ere maturity
<i>O. atropurpurea</i> .....	3-4 months.....	20-30 per cent.....	do. but more severely. Many seeds are under-developed	do.
<i>Lachnostylis capensis</i> .....	4-5 months.....	60-70 per cent.....	A fair number of seed is under-developed. No diseases known.	A few seeds fall prematurely.
<i>Echebergia capensis</i> .....	2½-4 months; removal of the pericarp decreases the period	10-50 per cent.....	<i>Ceratitis capitata</i> does much damage; Curculionidae also destroy many embryos; fruits lying on soil in moist sites are destroyed by moulds. Wild pigs destroy some seeds.	A fair number is blown prematurely some fruits are removed by birds and bats.
<i>Ficus capensis</i> .....	2-3 months . . . if receptacle dries round the seeds, the period is increased by several months—until the receptacle has decayed.	10-20 per cent.....	The receptacle is attacked by larvae of Dipter, and Lepidoptera, and by birds—many seeds being destroyed by these means. Many seeds are poorly developed, many other are attacked by moulds	A large number of "figs" falls prematurely.
<i>Celtis rhamnifolia</i> .....	2½-3½ months.....	30-40 per cent.....	Dipterous larvae and Curculionidae do much damage	A small number falls prematurely.
<i>Piptosporum Viridiflorum</i>	3-5 months.....	80-90 per cent.....	No diseases known.....	Very few seeds fall prematurely.
<i>Rhamnus prinoides</i> .....	4-6 months; removal of the pericarp assists germination	80-90 per cent.....	Dipterous larvae sometimes present; some seeds are under-developed. Fallen fruits sometimes destroyed by wild pig	do.
<i>Scutia Commersonii</i> .....	3-5 months; removal of the pericarp assists germination	70-80 per cent.....	Some seeds under-developed.....	Birds, bats, wind dislodge fair numbers

NOTE TO TABLE 5.

\*GERMINATIVE CAPACITY.

The *percentage of viable or germinable seed per 100*: in Nature the percentage that actually germinates is always infinitely lower than the *germinative capacity*, owing to community, and habitat, conditions, pathogenic fungi and destructive insects, birds, and mammals.  
The term is used by Bats (1913) and has the same meaning as "*germination index*" of R. MAYR (1910), and other German authors, and as "*final germination percentage*", of I. S. BAYNE (1915).  
The germinative capacity is established by (a) examination of dissected fruits and seeds (b) germination tests.

Table VI.

## QUANTITY OF NATURAL REGENERATION AND PRINCIPAL BIOTIC MORTALITY FACTORS.

Species.	Usual Amount and Condition of Young Regeneration Following a Full Fruiting Season: Normal Forest Localities.	Degree of Mortality.	Principal Biotic Factors Causing Mortality.
<i>Podocarpus elongata</i> L' Herit	Local: under some female trees 100 to 200 seedlings (from several days to several months old) per square metre are found. Usually produced in vigorous condition	Fair, but varying with season	<i>Fusarium</i> spp. kill large numbers; <i>Pestalotia</i> sp. nov. kills scattered plants.
<i>Podocarpus</i> Hook	Extremely abundant—under many trees as many as 100 to 300 seedlings (of several days to several months old) per square metre. A small proportion of the plants are produced with disease ( <i>Fusarium</i> ) but the majority are vigorous	High.....	<i>Fusarium</i> spp. kill off many thousands of young seedlings.
<i>Widdingtonia cupressoides</i>	Locally frequent; usually produced in vigorous condition.....	Very low.....	<i>Fusarium</i> spp. "damp off" a small number in moister sites.
<i>Olea laurifolia</i> .....	Extremely large numbers of seedlings are produced: under many trees as many as 500 seedlings (cotyledon-stage) per square metre are found. Owing to bird and mammal agency seeds often germinate in localities where no parents exist. Seedlings are delicate in rare instances only—usually they are very vigorous, if not attacked by diseases. The majority, soon after appearance, are attacked by the diseases mentioned under mortality factors	Very high; some sites are known to have lost 200 to 300 plants per square metre in several months	Chief diseases described in the writer's 1923 paper, q.v. <i>Perisporiaceae</i> and <i>Microthyriaceae</i> do some harm; <i>Corticium vagum</i> accounts for large numbers; <i>Fusarium</i> spp. "damp off" many plants just emerging from the endocarps. <i>Corvidae</i> kill the majority of 2-8 week old plants.
<i>Olea capensis</i> .....	Scattered seedlings appear throughout the forests, but are more abundant on open sites and along the margins. Occasional communities showing 100-200 seedlings per square metre are found. Produced vigorous and disease-free	Fair.....	As for above sp., but their influence is less severe.
<i>Olea foveolata</i> .....	Scattered seedlings only—seldom frequent. Produced in vigorous and disease-free condition	Low.....	As for <i>Olea laurifolia</i> , but their influence is very slight.
<i>Ocotea bullata</i> .....	Always a few seedlings appear throughout the better portions of the forests where dense layer-societies of shrubs, herbs, and ferns are either absent or sparse. Seedlings are exceptionally delicate when produced, but are always disease-free	Fair in plants under 12 months; slight in older	<i>Morenoella Phallipsii</i> Dge. kills off young plants. Older plants are attacked by the pit-horning larva of an unidentified beetle; the life-history of which has not yet been studied to completion; some of the bored plants die, but many die-back and re-shoot.
<i>Apodytes dimidiata</i> .....	Variable; some sites show from 50 to 200 plants per square metre, others show none. Plants are delicate but disease-free on first appearance	Very high in young-est stages	<i>Fusarium</i> spp. kill a large proportion of the seedling-crop. The "Blue-buck" ( <i>Cephaloporus monticola</i> ) browses off very large numbers of younger and older plants.

## QUANTITY OF NATURAL REGENERATION AND PRINCIPAL BIOTIC MORTALITY FACTORS.

Species.	Usual Amount and Condition of Young Regeneration Following a Full Fruiting Season : Normal Forest Localities.	Degree of Mortality.	Principal Biotic Factors (causing Mortality).
<i>Cassinopsis capensis</i> .....	Fair scattered, rarely in communities of more than 2 plants per square metre. Always vigorous and disease-free	Very low.....	Diseases unknown.
<i>Curtisia lignea</i> .....	Large numbers are produced, often 100 to 200 per square metre ; always vigorous and disease-free on first appearance	Fair.....	<i>Fusarium spp.</i> do much damage. <i>Meliola gangetica</i> ( <i>Perisporiaceae</i> ) kills many seedlings of 3 to 9 months of age.
<i>Platylophus trifoliatus</i>	Usually very rare ; on occasion locally fair ; rarely as many as 50 plants per square metre under parents growing in best, <i>sphacelanthus-treated sites</i> . Plants are delicate on first appearance, but are disease-free	Very low.....	Practically no biotic enemies. Physical factors of unfavourable nature, however, do more harm. (Vide J. F. Phillips 1925 : 1.)
<i>Cumouia capensis</i> .....	Very large numbers—many millions of minute seedlings wherever parents are plentiful ; over 3,000 plants per square metre in many instances. Plants are exceedingly small and very delicate on first appearance, and are attacked by <i>Fusarium spp.</i> as soon as they put forth radicles	Very high in first stages, slight in later stages, older than 6 months	<i>Fusarium spp.</i> do very great harm, killing off the greater part of the young plants. Large numbers are destroyed by birds ( <i>Cossypha caffra</i> , <i>C. bicolor</i> ; "Robins.")
<i>Nuxia floribunda</i> .....	Large numbers, usually scattered as to area ; locally dense seedling communities are occasionally found. Plants on first appearance are small but disease-free	Fair.....	<i>Fusarium spp.</i> kill off large numbers of the first stage plants, and <i>Meliola Hendelii</i> a fair number of the older ones
<i>Chilianthus arboreus</i> .....	Very occasional ; vigorous and disease-free.....	Very low.....	<i>Camptidom spp.</i> cover foliage of some young plants and slowly kill off the leaves.
<i>Ombia cynuosa</i> .....	Fair numbers locally, but in general, scattered or rare. Appearance of regeneration after fall of fruits is very long delayed (vide Phillips 1926 (1))—it being from 12 to 24 months ere germination takes place. Seedlings very delicate	High.....	<i>Fusarium, Camptidom spp.</i> do a little damage <i>Asterium, octidatula</i> less. Unfavourable physical factors do much harm.
<i>Ilex capensis</i> .....	Fairly large numbers of young plants are to be found under parent trees ; plants are vigorous and disease-free on first appearance	Slight.....	<i>Endogaster orbicularis</i> ( <i>Microthyriaceae</i> ) kills a small number of seedlings.
<i>Kigelia africana</i> .....	Fair quantities are produced, but the plants are usually well scattered. They are vigorous and fast-growing from the very beginning, and are disease-free	Slight.....	<i>Fusarium spp.</i> kill a small number of the youngest plants ; the older plants sometimes suffer from attacks of the larva of <i>Afraca horta</i> ( <i>Lepidoptera</i> ).
<i>Sceloporus Munduli</i> .....	Rare ; vigorous and disease-free.....	Very low.....	No diseases known.

Table VI.—(Continued).

## QUANTITY OF NATURAL REGENERATION AND PRINCIPAL BIOTIC MORTALITY FACTORS.

Species.	Usual Amount and Condition of Young Regeneration Following a Full Fruiting Season : Normal Forest Localities.	Degree of Mortality.	Principal Biotic Factors Causing Mortality.
<i>S. Zeyheri</i> .....	Rare ; vigorous and disease-free.....	Very low.....	<i>Capnodium spp.</i> do some harm to foliage of some young plants.
<i>Triplaris alnifolia</i> .....	Occasional ; vigorous and disease-free.....	Low.....	No diseases known.
<i>Diospyros rhynchophylla</i> .....	Very occasional ; vigorous and disease-free.....	Very low.....	<i>Capnodium spp.</i> do some harm to foliage of some young plants.
<i>Myrsine melanophloeos</i> .....	Very large numbers are found near parent trees—as many as 1,000 to 1,500 first-stage plants may be found per square metre. Seedlings occur in Macchia, whither the seeds have been borne by birds. The plants are vigorous on first appearance, but develop badly-shaped stems and root-systems ; they are liable to early fungus attack.	High.....	<i>Fusarium spp.</i> and <i>Pestalotia sp. nov.</i> kill off many thousands of first-stage plants.
<i>Fauria McNaughtonii</i> .....	Very large numbers produced under parent trees, absolutely no plants in forest where parents do not occur. As many as 50 to 100 plants, first-stage, may be found per square metre, under or adjacent to parent-trees. Plants are vigorous and fast-growing from the beginning.	Slight.....	No biotic diseases are known, apart from the slight harm caused by <i>Hysterostoma Fauriae</i> ( <i>Polystromellaceae</i> ).
<i>Virgilia capensis</i> .....	If soil containing the hard seeds is distributed by trampling, cultivation, or fire, germination of <i>Virgilia</i> is excellent ; seed not stimulated remains dormant for over 30 years. As many as 1,000 seedlings per square metre are found on burnt ground that contained germinules of the <i>sp.</i>	Very high.....	<i>Peronospora sp.</i> and <i>Fusarium spp.</i> kill very large numbers of first-stage plants. The larva of <i>Euxoa segetis</i> Schiff. <i>sp</i> ( <i>Lepidoptera</i> ) ("Cut-worms") do considerable damage. <i>Mice</i> and <i>Voles</i> eat off thousands of later-stage plants. "Blueback" ( <i>Cephalophus</i> ) also do much harm.
<i>Gonioma Kamassi</i> .....	Rare ; occasionally locally frequent ; vigorous, disease-free.....	Slight.....	No biotic diseases are known.
<i>Carlissa arduina</i> .....	Very occasional ; vigorous and disease-free.....	Very low.....	<i>Capnodium spp.</i> do some harm to foliage of some young plants.
<i>Aconkanthera vaukena</i> .....	Occasional ; vigorous and disease-free.....	Very low.....	No diseases known.
<i>Calodendron capense</i> .....	Rare ; scattered ; vigorous and disease-free.....	Very low.....	No diseases known.
<i>Toddalia lanceolata</i> .....	Very occasional ; locally frequent. Vigorous and disease-free.....	Low.....	<i>Fusarium spp.</i> "damp off" a few plants ; "Blueback" browse a few.

Table VI.—Continued.)

## QUANTITY OF NATURAL REGENERATION AND PRINCIPAL BIOTIC MORTALITY FACTORS.

Species.	Usual Amount and Condition of Young Regeneration Following a Full Fruiting Season: Normal Forest Localities.	Degree of Mortality.	Principal Biotic Factors Causing Mortality.
<i>Figaria vavil.</i> .....	Rare; tender in earliest stages, hardy in later.....	Low.....	No diseases known.
<i>Pteroclastrus variabilis</i> ..	Very fair numbers of seedlings are produced; vigorous and disease-free on first appearance	Low.....	<i>Fusarium</i> spp. "damp off" a small number of first-stage plants; <i>Cupnodium</i> spp. harm foliage of older ones.
<i>Elaeodendron croceum</i> ....	Frequent; hardy and slow-growing, disease-free.....	Medium.....	<i>Asterodictis solaris</i> (Doridiaceae) kills a large number of plants of various ages, <i>Fusarium</i> spp. "damp-off" first-stage seedlings.
<i>E. capense</i> .....	Frequent; hardy and slow-growing, disease-free, on first appearance	Medium.....	<i>Asterodictis solaris</i> (Doridiaceae) kills a large number of plants of various ages, <i>Fusarium</i> spp. "damp-off" first-stage seedlings.
<i>E. Krausslanum</i> .....	Occasional; vigorous and disease-free on first appearance.....	Low.....	<i>Cupnodium</i> spp. kill off some plants
<i>Celastrus acuminatus</i> ....	Occasional; locally abundant; vigorous and disease-free on first appearance	Low.....	<i>Fusarium</i> spp. "damp off" some young plants; some killed by <i>Cupnodium</i> spp.
<i>C. pedunculatus</i> .....	Occasional; locally abundant; vigorous and disease-free on first appearance	Low.....	<i>Fusarium</i> spp. "damp off" some young plants; some killed by <i>Cupnodium</i> spp.
<i>C. buxifolius</i> .....	Frequent; vigorous and disease-free on first appearance.....	Low.....	Youngest plants often "damped off" by <i>Fusarium</i> spp.
<i>Halleria lucida</i> .....	Abundant; vigorous and disease-free on first appearance.....	Low.....	Many plants are browsed by "Blueback."
<i>Electronia obovata</i> .....	Occasional; vigorous and disease-free on first appearance.....	Low.....	<i>Melaleuca falcata</i> kills a few first-stage plants.
<i>Electronia Munzii</i> .....	Frequent; vigorous and disease-free on first appearance.....	Low.....	Browsed by "Blueback"; in moist sites <i>Fusarium</i> spp. "damp off" a few first-stage plants.
<i>P. ventrosa</i> .....	Occasional; vigorous and disease-free on first appearance.....	Low.....	<i>Cupnodium</i> spp. kill a few seedlings.
<i>Burchellia capensis</i> .....	Abundant; vigorous and disease-free on first appearance.....	Low.....	"Blueback" browses off fair numbers of young plants.
<i>Gardenia Rothmannia</i> ....	Occasional; usually scattered; vigorous and disease-free on first appearance	Low.....	No diseases known.

Table VI.—(Continued.)

## QUANTITY OF NATURAL REGENERATION AND PRINCIPAL BIOTIC MORTALITY FACTORS.

Species.	Usual Amount and Condition of Young Regeneration Following a Full Fruiting Season: Normal Forest Localities.	Degree of Mortality.	Principal Biotic Factors Causing Mortality.
<i>Royena lucida</i> .....	Abundant; vigorous and disease-free on first appearance.....	Low.....	<i>Capnodium</i> and <i>Fusarium</i> spp. destroy a small number of first-stage plants.
<i>Euclea macrophylla</i> .....	Very occasional; vigorous and disease-free on first appearance.....	Low.....	No diseases known.
<i>E. racemosa</i> .....	Very occasional; vigorous and disease-free on first appearance.....	Low.....	No diseases known.
<i>E. lanceolata</i> .....	Very occasional; vigorous and disease-free on first appearance.....	Low.....	No diseases known.
<i>Sideroxylon inerme</i> .....	Rare; vigorous and disease-free on first appearance.....	Low.....	No diseases known.
<i>Rhus laevigata</i> .....	Rare; vigorous and disease-free on first appearance.....	Low.....	Sought by "Blue-buck" and "Grijshuck" ( <i>Pediatus fragilis</i> ).
<i>Brachylaena nerifolia</i> ....	Occasional—along river beds; vigorous and disease-free on first appearance	Low.....	No diseases known.
<i>Tarchonanthus camphoratus</i>	Rare; occasional in littoral bush; vigorous and disease-free on first appearance	Low.....	No diseases known.
<i>Sparmannia africana</i> ....	Abundant; often appearance in diseased condition.....	Medium.....	Large numbers are "damped off" by <i>Fusarium</i> spp.; <i>Excoecia agilis</i> (Cutworm) destroys fair numbers.
<i>Trichocladus erinitus</i> ....	Frequent; vigorous and disease-free on first appearance.....	Low.....	Bucks browse off large numbers in some localities.
<i>T. ellipticus</i> (rare and local)	Rare; vigorous and disease-free on first appearance.....	Low.....	Bucks do some harm.
<i>Ochna arborea</i> .....	Occasional, far scattered; vigorous and disease-free on first appearance	Low.....	No diseases known.
<i>O. atropurpurea</i> .....	Very occasional, and local; vigorous and disease-free on first appearance	Low.....	No diseases known.
<i>Lachnostylis capensis</i> ....	Frequent; vigorous and disease-free on first appearance.....	Low.....	No diseases known.
<i>Ekbergia capensis</i> .....	Abundant; tender on first appearance, and sometimes diseased....	High.....	<i>Fusarium</i> spp. kill off large numbers of first-stage plants; <i>Excoecia agilis</i> (Cutworm) takes heavy toll. Buck browse larger seedlings.
<i>Ficus capensis</i> .....	Rare; vigorous and disease-free on first appearance.....	Low.....	No diseases known.

Table VI.—(Continued.)

## QUANTITY OF NATURAL REGENERATION AND PRINCIPAL BIOTIC MORTALITY FACTORS.

Species.	Usual Amount and Condition of Young Regeneration Following a Full Fruiting Season: Normal Forest Localities.	Degree of Mortality.	Principal Biotic Factors Causing Mortality.
<i>Celtis rharnifolia</i> .....	Rare; vigorous and disease-free on first appearance.....	Low.....	<i>Fusarium spp.</i> take toll of youngest plants.
<i>Pittosporum viridiflorum</i> .	Rare; vigorous and disease-free on first appearance.....	Low.....	No diseases known.
<i>Rhamnus prinoides</i> .....	Abundant; vigorous and disease-free on first appearance.....	Low.....	Buck destroy some plants.
<i>Scutia Commersonii</i> .....	Occasional; vigorous and disease-free on first appearance.....	Low.....	Buck destroy some plants.





## Appendix II.

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THE  
BEHAVIOUR OF ACACIA `MELANOXYLON R. Br.  
(“ Blackwood ”)  
IN THE FORESTS OF THE KNYSNA.

[*Vide* Phillips, 1928: (1).]



THE BEHAVIOUR OF *ACACIA MELANOXYLON* R.Br.  
 "BLACKWOOD") IN THE FORESTS OF THE KNYSNA.\*

INTRODUCTORY REMARKS.

SOME interesting and important features of ecological, silvicultural and economic nature are brought to light in the study of the behaviour of the exotic *Acacia melanoxylon* R.Br., in the indigenous forests of the Knysna. The objects of the present communication are to describe briefly observations and experiments connected with the behaviour of the species under study, and to outline the conclusions drawn as a result of the investigations.

BRIEF HISTORY OF INTRODUCTION.

So far as the writer has been able to trace, the species was introduced to the George-Knysna-Zitzikama region at about the same time as the "Blue Gum" (*Eucalyptus globulus*)—1856. Captain Harison, the first Conservator of the George-Knysna-Zitzikama forests, in 1874 wrote that large trees of the species were to be found in the gardens of Knysna village. From other references in Harison's correspondence it seems that the "Blackwood" had been extensively planted in the gardens at George.

As the Colonial Secretary in 1876 pressed for the planting of "burns" and other gaps in the forests, and urged the extension of the limits of the indigenous forests by means of exotics, Harison obtained supplies of "Blackwood" seed from McGibbon, Curator of the Government Gardens, Capetown. The Conservator commenced raising the species in his own garden at Concordia. Ere the young plants were large enough to be transplanted to the forest or macchia, Roland Trimen published a note on the "Australian Bug," reputed to be a severe pest of "Blackwood." Harison immediately grew sceptical as to the advisability of planting so susceptible a species and for the time being checked his planting operations. His fears evidently were well-founded, for in March, 1877, the insect actually did appear on "Blackwood" in the village and environs of George. Harison so much feared that the indigenous forest trees would become infected, that he issued stringent orders to the Forest Rangers *re* the felling and burning of all suspicious-looking trees, exotic and indigenous alike. So great was the alarm caused by the outbreak, that no further attention was paid to the planting of "Blackwood" until 1889, when D. E. Hutchins, Conservator of Forests at Knysna, planted it on a small scale as "live" fire-belt. He was succeeded in this work by Conservator Cooper in 1890. Comparatively few trees were planted in these 1889-1891 operations, and such almost entirely along the forest margins. Indeed it may be said that until 1909 no serious attempt to introduce "Blackwood" to the forests proper had been made.

In 1909 J. S. Henkel, then Conservator of Forests at Knysna, referring to the natural regeneration of the indigenous forests and the inter-planting of these forests with exotics, wrote (Annual Report, Chief Conservator of Forests, for 1909, p. 17):—" . . . . . There are profound relationships existing between species which it is essential to maintain in order to produce the best results. It is, however, possible that, by the introduction of exotics, the natural process of regeneration may be accelerated and a quicker return

\* *Vide* Phillips 1928; (1)

obtained by a judicious introduction of a faster growing species. Much thought has been given to this subject and interesting examples of success have been discovered. A remarkable case at White Els Bush may be quoted. It would appear that, either by accident or design, a single blackwood tree (*Acacia melanoxylon*) was introduced into the forest. The original tree is standing, though somewhat injured by fire. From this tree, radiating in all directions, an excellent group of well-grown blackwoods has been produced. In some cases the dense canopy of indigenous trees has been pierced by the vigorous blackwoods. This has been done without any assistance from man and notwithstanding a dense growth of weeds. . . ."

From about 1910 until 1922 the planting of gaps in exploited forest received some attention, while living belts were formed round the margins of a number of forests. A very large proportion of the seedlings and root-suckers planted was either killed or seriously damaged by Elephant, Bushbuck (*Tragelaphus sylvaticus*), Grijsbok (*Pediotragus tragulus*), Bluebuck (*Cephalophus monticola*), Wild Pig (*Potamochoerus choeropotamus*), and Cattle.

## THE BEHAVIOUR OF *ACACIA MELANOXYLON* R.BR.

### I. GENERAL OBSERVATIONS.

Apparently the objects of the introduction of "Blackwood" into the exploited portions of the indigenous forests have been (a) the subjugation of the rampant weeds following excessive removal of the upper canopy on one and the same site, (b) acceleration of the process of natural regeneration of indigenous species.

During examination of various portions of the Deepwalls forests in 1922-1923, and of the Gouna and Sourflats forests in 1923, it was noted repeatedly that "Blackwood" had in most instances fulfilled the first duty expected of it—killing off of weeds such as *Helichrysum petiolatum*, *H. parriflorum*, *Plectranthus fruticosus*, and *Rubus* spp. So far from assisting in the processes of establishment, growth, and development of natural regeneration of the native trees, it appeared actually to retard these processes. Regeneration of native species was not only very, very rare under stands of *Acacia melanoxylon*, but also appeared non-assertive and moribund.

Two reasons for this poverty of regeneration were thought likely to exist: (a) the "Blackwood" when planted close together (4×4, 6×6, or even 8×8 feet) on small clearings in the forest, *reduced the Light-intensity so considerably that native seedlings were unable to establish themselves, or, if they were able to establish themselves, were unable to develop normally*; (b) the "Blackwood" *drew so strongly upon the supply of soil moisture that regeneration of the relatively delicate native species was unable to establish itself, or at all events to develop.*

With these as *hypotheses*, the writer set out to test by definite experiment their *veracity and relative importance*.

### II. THE REACTION OF *Acacia Melanoxylon* R.BR. ON THE LIGHT-INTENSITY.

The Light-intensity at ground-level in many "Blackwood" stands, ranging from 4 to 14 years of age, was determined by means of Clements's Stopwatch Photometer. Values as low as 1/50, 1/100,

1/150, 1/200, 1/300, 1/400, 1/500, 1/700 of full Sunlight were registered. In no single instance did weed-growth of any kind exist under the trees nor did regeneration of native trees occur—apart from occasional, poorly-developed plants of *Royena lucida*, *Burchellia capensis*, *Plectronia Mundtii*, *Olea capensis*, *Celastrus acuminatus* and *C. buxifolius*. In several stands showing Light-intensities of 1/30, 1/40, and in one showing 1/100, some poorly-grown seedlings, several inches high, of *Podocarpus Thunbergii* Hook., *P. elongata* L'Herit., *Olea laurifolia*, *Apodytes dimidiata*, *Curtisia faginea* occurred, together with a few seedlings of the species previously listed.

From a series of Light-intensity experiments carried out at Deep-walls it was known that seedlings of *P. Thunbergii*, *P. elongata*, *O. laurifolia*, *A. dimidiata*, *C. faginea* could withstand for periods of 6-12 months such low Light-intensities as 1/1000-1/2000, that they existed but scarcely grew under values 1/500-1/1000, that they grew moderately well but were soft and delicate under values 1/200-1/500, and that they were vigorous and assertive under values 1/5-1/40. Accordingly cultures of plants of these species, of known age (usually 6-12 months from germination) and of known history (raised in nursery under known Light-intensity and known average moisture-content of the soil), were placed under several *A. melanoxylon* stands, the average Holard (total moisture-content of the soil) of the soil in the tins being regulated, and in every instance being kept at a value as near as possible to the known optimum for each species. The soil used was good, porous forest Clay-loam (15-20 per cent. Clay) of the type occurring on the sites where the "Blackwood" stands had been planted. The soil-surfaces were sealed so that the Holard might be regulated with care.

The responses shown by the cultures are summarized in *Table I*. These are of considerable interest and importance: they reveal the fact that in the instances of stands showing a Light-intensity lower than 1/200 at ground-level, development of the culture plants was not as good as that shown by plants of the same age, growing in the same soil, and receiving the same amount of water, but living under stands of *A. melanoxylon*, experiencing stronger Light-intensities at ground-level; furthermore, they show that while development of the culture plants under Light-intensities lower than 1/200 was not vigorous, the plants nevertheless, on account of receiving sufficiency of water, could live and could grow slowly. The information yielded by the cultures, combined with the knowledge that indigenous regeneration was sparse and very poorly developed under *A. melanoxylon* stands experiencing such congenial intensities as 1/10, 1/25, 1/40, at ground-level, seemed to suggest that the Light-intensity reaction was not the prime one, although evidently an important additional one.

Table I.

RESPONSES OF HOLLARD-REGULATED CULTURES GROWN UNDER ACACIA MELANOXYLON STANDS OF FIVE DIFFERENT  
INTENSITIES OF LIGHT.

Species.	Average Light-intensity (9 a.m.-4 p.m.) under which the plants were raised.	Average Hollard of the Nursery bed. (Dry-wt.).	Average Light-intensity at Ground-level, of the "Blackwood" stand under which the Cultures were Placed.	Average regulated Hollard of the Culture Tins. (Dry-wt.).	Original Nature of the Plants.	Nature at End of 6 Months. Life under the "Blackwood" stands.	Height-increment in 6 Months.
<i>P. Thunbergii</i> Hook....	1/10	6	1/25	6	Vigorous	Vigorous	Inches.
	1/10	40	1/100	40	Vigorous	Very fair	24-3
	1/10	40	1/200	40	Vigorous	Fair, but tender	1-14
	1/10	40	1/400	40	Vigorous	All alive but show little vigour	4-1
<i>P. elongata</i> L'Hérit....	1/10	40	1/600	40	Vigorous	Vigour nil; but all alive	0
	1/10	35	1/25	35	Vigorous	Vigorous	3-8 1/2
	1/10	35	1/100	35	Vigorous	Very fair	2
	1/10	35	1/200	35	Vigorous	Fair	1
<i>O. laurifolia</i> .....	1/10	35	1/400	35	Vigorous	All alive, little vigour	4
	1/10	35	1/600	35	Vigorous	Vigour nil; all alive	0
	1/10	40	1/25	40	Vigorous	Vigorous	2
	1/10	40	1/100	40	Vigorous	Fair	1
<i>A. dimidiata</i> .....	1/10	40	1/200	40	Vigorous	Very fair	1
	1/10	40	1/400	40	Vigorous	Fair, but with less vigour than those under 1/2000	4
	1/10	40	1/600	40	Vigorous	Moribund	0
	1/10	45	1/25	45	Vigorous	Vigorous	3
<i>C. taginea</i> .....	1/10	45	1/100	45	Vigorous	Very fair	3
	1/10	45	1/200	45	Vigorous	Fair	1 1/2
	1/10	45	1/400	45	Vigorous	Poor	1
	1/10	45	1/600	45	Vigorous	Poor, moribund	1/2
	1/10	40	1/25	40	Vigorous	Vigorous	3 1/2
	1/10	40	1/100	40	Vigorous	Very fair	3
	1/10	40	1/200	40	Vigorous	Fair	1
	1/10	40	1/400	40	Vigorous	Poor; vigour nil	0
	1/10	40	1/600	40	Vigorous	Moribund	0

## II. THE REACTION OF *Acacia melanoxylon* R.Br. ON THE HOLARD.

### 1. *Determination of the Holard in Acacia melanoxylon stands.*

With the object of determining the average Holard at definite depths under stands of the species, a series of soil cores were taken by means of a soil-borer, bi- or tri-weekly, for the space of 12 months at depths of 6, 12, 18 and 24 inches at certain stations, and at depths of 6 and 12 inches only at others. The cores were placed at once in air-tight containers, weighed, oven-dried until constant weight (usually after 12 to 18 hours at 105 deg. Fahr.), desiccated over Calcium chloride for a further 12 hours, then rapidly re-weighed.

A summary of Holard values, together with notes concerning the stands, the Light-intensity at ground-level, and the occurrences of regeneration of native species, is given in Table II.

The data shown in Table II definitely show that the soil under "Blackwood" stands is considerably drier than that obtained from sites within the same locality but free of the aforementioned species; the Holard, indeed, is reduced to values closely approaching the Wilting coefficient or the Echard (non-available moisture-content of the soil) for the particular soils and the particular species.

The greatest reduction appears to be at depths of 18 and 24 inches—bisects show that the greatest development of the rootlets of "Blackwood" occurs between 15 and 24 inches, hence the drier nature of the soil between these limits. The control Holard values given in Table II show the soil at 18 and 24 inches to be drier than that at 6 and 12 inches; here, again, the reason is that the greatest development of feeding rootlets of the trees (native species) occurs at the 18 to 24 inches level.

Quadrats of 1 square-meter area, set out under the stands 1, 2, and 5 described in Table II, revealed the information (a) that the increment of the naturally-established native seedlings was either nil or exceedingly small; (b) that many first stage seedlings of *P. Thunbergii*, *O. laurifolia*, *Apodytes dimidiata*, *Curtisia faginea*, and *Royena lucida* died before they could establish themselves—unless the weather happened to be particularly wet at the time of germination of the seed; (c) that a number of the seedlings of several inches in height wilted and died during dry spells—that is, if rain did not fall for the space of 7 to 21 days, or if Foehn ("Berg," or warm, dry winds) winds were prevalent.



Table. II.

AVERAGE HOLARD VALUES AT VARIOUS DEPTHS UNDER A. MELANOXYLON STANDS, TOGETHER WITH HOLARD VALUES  
FOR CONTROL SITES.

Stand. (X:1)	Light-intensity and Aspect.	Natural Regeneration of Native Tree Species.	Depth of Core.	Nature of the Soil.	Average Holard. (Dry-wt.).	Nature of Control Site.	Average Holard. (Dry-wt.).
1	1/40. Flat....	Few P. Thumbergii, Apodytes, Curtisia; O. laurifolia and Royena lucida frequent. All poor and non-assertive	Inches. 6 12 18 24	Humus and sandy loam Clay loam Clay loam	0 19 17 17	Light: 1/50, fairly open high forest, with P. Thumbergii, O. laurifolia, Apodytes, Curtisia frequent	0 40 35 32 30
2	1/50. Flat....	Few P. Thumbergii, Curtisia, O. laurifolia, Burchellia capensis, Plectronia Mundtii, and Celastrus buxifolius. All poor; some dying at each dry spell	6 12 18 24	Humus and sandy loam Clay loam Clay loam (15% clay)	16 16 14 13	Light: 1/100; closer high forest with above spp. and a second layer of smaller trees	43 36 30 28
3	1/40. North...	No regeneration; a few Blechnum punctu- latum and Aspidium capense	6 12 18 24	Humus and sandy loam Sandy loam Sandy loam (8% clay)	14 12 11 10	Light: 1/200; close high forest rich in P. Thumbergii and O. laurifolia, with layer of Trichocladus erinitus	35 33 26 26
4	1/25. North...	No regeneration; a few Aspidium capense	6 12 18 24	Humus and sandy loam Sandy loam Sandy loam (10% clay)	12 10 —	Light: 1/75; open high forest, with P. elongata, Ocotea bullata, and P. Thum- bergii	30 27 —
5	1/100. South..	A few P. Thumbergii, P. elongata, Apodytes, and Olea laurifolia. All poor	6 12 18 24	Humus and clay loam Clay loam Clay loam (18% clay)	17 15 —	Light: 1/150, high forest rich in P. Thum- bergii, O. laurifolia, and with some Tri- chocladus erinitus	41 35 —

## 2. Holard Experiments.

(i) On 4-meter-square quadrats set out under stands 1, 2 and 5 described in Table 2, carefully-selected, viable seeds of *Curtisia faginea*, *Olea laurifolia*, *Podocarpus Thunbergii* were sown; 300 of each species to a quadrat, 3 quadrats to a stand. The seeds were protected from birds and mammals by means of fine wire-mesh. The degree of germination was recorded for each species on each of the 9 quadrats. A summary of the *germination percentages* and *establishment percentages* is given in Table 3; it is seen that while the *percentage of germination was high* (compare percentages shown by the same stock of seed, sown at the same time, on 9 control quadrats under normal forest conditions, but not far removed from stands 1, 2, and 5—Table 4) *the percentage of establishment* was extremely low, despite the very fair conditions of light the quadrats received.

Table III.

SEMINARIA UNDER A. MELANOXYLON STANDS: % GERMINATION AND ESTABLISHMENT.

Stand.	Average Holard. (6 Inch).	Average Light-intensity.	C. faginea.		O. laurifolia.		P. Thunbergii.	
			Per cent. Germination. (: x : 1)	Per cent. Establishment.	Per cent. Germination.	Per cent. Establishment.	Per cent. Germination.	Per cent. Establishment.
1	% 19	1/40	% 57	% 5	% 81	% 7	% 65	% 2
2	16	1/50	62	4	78	5	51	3
5	18	1/100	69	4	85	10	70	2

Table IV.

SEMINARIA UNDER NORMAL FOREST CONDITIONS: CONTROL ON ABOVE.

Forest.	Average Holard. (6 Inch).	Average Light-intensity.	C. faginea.		O. laurifolia.		P. Thunbergii.	
			Per cent. Germination.	Per cent. Establishment. (: x : 1)	Per cent. Germination.	Per cent. Establishment.	Per cent. Germination.	Per cent. Establishment.
1	% 40	1/50	% 59	% 83	% 75	% 90	% 68	% 90
2	40	1/100	60	90	82	93	64	90
3	42	1/30	63	91	75	88	66	88

### Notes to Tables 3 and 4.

(: x : 1). Percentage of establishment is calculated on the number of plants that actually were yielded by the seed, and on the proportion of these that survived at the end of 4 months.

The overwhelming majority of the deaths on quadrats under "Blackwood" stands was due to wilting of the plants on account of insufficient water.

(ii) Blocks of soil 9 inches deep by 18 inches in length—taken from "Blackwood" stands and containing a few naturally-established seedlings each of *P. Thunbergii*, *P. elongata*, *O. laurifolia*, *Apodytes*, *Curtisia*, and *Royena lucida*—were placed in tins, the soil-surfaces of the tins were sealed with a mixture of parawax-petrolatum; the sealed cultures were kept under a Light of 1/50, and were never watered, the object being to cause wilting of the seedlings very gradually. The history of the experiment is summarized in Table 5.

Table V.

WILTING OF NATURALLY ESTABLISHED SEEDLINGS IN SEALED SOIL BLOCKS  
REMOVED FROM A. MELANOXYLON STANDS.

Block No.	Original Holard of the Block, at 3 Inches. (Dry-wt.).	Species of Seedlings.	Wilted at. (Dry-wt.).	Time Required.	Soil Nature.
	18	<i>P. elongata</i> ..... <i>P. Thunbergii</i> ..... <i>O. laurifolia</i> ..... <i>Apodytes</i> ..... <i>Curtisia</i> ..... <i>Royena</i> .....	10 11 12 14 12 12	8 to 12 days	Clay loam, 15 per cent. clay, humus 10 per cent.
2	16	<i>P. elongata</i> ..... <i>P. Thunbergii</i> ..... <i>O. laurifolia</i> ..... <i>Apodytes</i> ..... <i>Curtisia</i> ..... <i>Royena</i> .....	10 12 12 13 12 12	5 to 7 days	Sandy loam 7 per cent. clay, humus 8 per cent.
3	22	<i>P. elongata</i> ..... <i>P. Thunbergii</i> ..... <i>O. laurifolia</i> ..... <i>Apodytes</i> ..... <i>Curtisia</i> ..... <i>Royena</i> .....	11 11 12 13 13 13	14 to 21 days	Clay loam, 18 per cent. clay, humus 10 per cent.

Note to Table 5.

The cultures were kept in well-aerated, cool sites.

The experiment indicates that were no rain to fall for a period of 14-21 days the seedlings of Block 3 would succumb to drought, that were the rain to be withheld for 8-12 days from Block 1, death would follow, and that the plants of Block 2 could not survive unless rain fell within 5 to 7 days. The fact that the Holard of the Blocks so nearly approached the Echard for the soil and for the seedlings used is well shown up, especially in the instance of the second Block, where the Holard is but 3-6 per cent. above the Echard.

(iii) Two 4-square-meter quadrats per stand were set out under "Blackwood" stands 2 and 5 (*vide* Table 2 for details); these quadrats each showed a few seedlings of the following species: *P. elongata*, *P. Thunbergii*, *O. laurifolia*, *Apodytes*, *Curtisia*, and *Royena lucida*. These quadrats were watered so that their average Holards were appreciably increased, as shown in Table 6, page 12; 4 control quadrates containing seedlings of the same species were left unwatered, the object being to compare the nature of the seedlings

on Holard-increased quadrats with that of seedlings on quadrats of low Holard. Table 6 is a summary of the responses shown by the various species—the influence of watering was evident at first sight: general improvement of the condition of the plants, and practically an entire absence of mortality. Unwatered plants, however, fared badly, especially as several drought and Foehn-wind periods occurred during the course of the experiment.

From the determination of Holard at several depths in various stands of *A. melanoxylon*, germination-establishment experiments, the un-watered soil block experiments, and the increased Holard experiment, it is manifest that *A. melanoxylon* reduces the soil-moisture to a degree unfavourable to the normal development of the seedlings of *P. Thunbergii*, *P. elongata*, *Apodytes*, *Olea laurifolia*, and *Curtisia*, and that it occasionally brings about the death of seedlings of these species by reducing the Holard to points either equivalent to, or below, the Echard. It is known that seedlings of *Ocotea bullata*, *Platylophus trifolius*, *Cunonia capensis*, and *Ekebergia capensis* are just as sensitive to a greatly reduced water-content as the species listed in the foregoing Holard experiments, and there can be little doubt that *A. melanoxylon* would have the same detrimental influence on them.

Referring, then, to the two hypotheses concerning the poverty of regeneration of indigenous species under "Blackwood" stands, it is seen that both were actually true, but that the major rôle is played by the water-reducing reaction of the species, and the minor by that of Light-intensity reduction. Combined, the two reactions are exceeding potent.

#### THE RATE OF LOSS OF WATER FROM FOLIAGE UNDER NORMAL CONDITIONS OF TEMPERATURE AND HUMIDITY OF THE AIR.

In passing, a few remarks concerning the rate of loss of water from foliage of *Acacia melanoxylon* will assist in explaining why the species makes such strong demands upon the soil-moisture:—

- (i) The actual loss per unit area of the simple, leaf-like *phyllodes*, or petioles so flattened as to set their surfaces vertically, is not extremely high, but is higher than the loss from equal areas of the surfaces of leaves of most of the indigenous forest trees, except *Virgilia*, *Ocotea*, *Curtisia*. On the other hand, the total transpiring surface of the average *A. melanoxylon* is considerably greater than that of many of the species indigenous to the forests—the *phyllodes* are exceedingly numerous and in *toto* form a well-knit transpiring surface.

The following is a typical example of the transpiring capacity of the species:—

Transpiration per square-metre of phyllode-surface per hour: 19.17 c.c.

Hours: 11 a.m.—4 p.m. 14th August, 1925.

Temperature during this period (shade):—

11 a.m.	58.0	deg. Fahr.
12 noon.	59.0	..
1 p.m.	58.5	..
2 p.m.	58.5	..
3 p.m.	55.0	..
4 p.m.	54.0	..

*Temperature Maximum in Sun* during this period.

101.25 deg. Fahr.

*Light-intensity* (in transpiration screen).

0.5 of full day-light.

*Sunshine.*

Sky unclouded, full sunshine throughout period.

*Relative Humidity* during the period.

11 a.m.	68	per cent.
12 noon.	67	..
1 p.m.	67	..
2 p.m.	68	..
3 p.m.	70	..
4 p.m.	74	..

*Wind.*

Forces 0 to 1, Beaufort Scale.

During the same period, *Ocotea* and *Curtisia* transpired 20.8 c.c. and 25.0 c.c. per square-metre respectively.

- (ii) Experiments on the rate of water-loss during the drying of leaves detached from the parent tree were carried out, employing the methods described by Bews (1923: 44-56), and showed the following points of interest:—

*Phyllodes* of *A. melanoxylon* suddenly removed from a fully saturated atmosphere (bell-jar over water, with branchlets standing in the water for 12 hours) and placed in an incubator at a constant temperature of 25 deg. C. (77 deg. Fahr.) and relative humidity 70 per cent., at the end of 24 hours showed a *considerably smaller water-balance* than either *Ocotea* or *Curtisia* leaves submitted to the same treatment. Thus:—

<i>A. melanoxylon</i>	showed a balance of	21.01	per cent.
<i>Ocotea</i>	.. .. .	26.79	..
<i>Curtisia</i>	.. .. .	59.30	..

Bews (*loc cit.*, p. 50), employing a temperature of 25 deg C., found that in the same time (24 hours) water-balances were shown by the species studied as follows:—

<i>Greyia Sutherlandi</i>	... ..	16	per cent.
<i>Protea Roupelliae</i>	... ..	20	..
<i>Podocarpus elongata</i> L'H.	... ..	38	..
<i>Crassula</i> sp.	... ..	66	..

It seems then that *A. melanoxylon* is *less resistant* to water-loss than *Ocotea*, *Podocarpus elongata* L'Herit., *Curtisia*, and *Crassula* sp., and more resistant than *Greyia* and *Protea Roupelliae* on being suddenly exposed to desiccating conditions. It is known that Holard decrease is greatest in times of high temperature and low relative humidity, and this possibly is due to the greater demands made by the *Acacia* upon the moisture in the soil, at such times.



## THE POSSIBILITY OF UNDESIRABLE SPREAD.

Assuming then that *Acacia melanoxylon* is definitely detrimental to the regeneration of the indigenous trees of the Knysna, on account of its reactions on Light and on Holard, the question whether there is danger of the species spreading in the natural forests to an undesirable extent immediately arises. The following points throw much light upon the matter.

1. *A. melanoxylon* produces seeds in the greatest profusion: some trees are never found without seed, some seed several times per year, others bear rich crops annually. It is estimated, on the basis of counts of seeds produced by certain branches of certain trees, that the average "Blackwood" of 10-14 years of age produces about 250,000 seeds per annum.

2. The seeds are 90-99 per cent. viable.

3. The seeds are dispersed by Elephant, Bushbuck, Grijsbok, Bluebuck, Wild Pig, Field Mice, Moles, and Cattle. Elephant, the bucks, Wild Pig, and Cattle browse on the foliage of the "Blackwood," accidentally swallow the seeds, and pass these through their systems; when deposited with the faeces the seeds are much softened and germinate within 7-21 days.

Occasionally Bushdoves, *Amydrus morio* ("Red-winged Starling"), and domestic fowl carry the seed over short distances, but the passing of the seed through the systems of these birds does not assist germination.

On rare occasions Ants may be seen bearing freshly-fallen seeds over short distances for the sake of the oily matter at the hilum.

The seeds are carried long distances by water—heavy rains, streams, and rivers. The planting of small patch of "Blackwood" near the banks of the "Rondebos" stream, Deepwalls, in 1915, has been responsible for the dispersal of seed and the consequent establishment of seedlings, poles, and small trees of the species along the whole length of the "Rondebos" and allied streams—a distance of not less than 20 miles of stream-bank. In the same manner, "Blackwood" planted at Jubilee Creek, Millwood, about 1913, has supplied seed for dispersal by the Forest Creek stream and the "Hontini" River—dense patches of regeneration of all sizes are to be found along the banks of these water-courses.

4. The small, hard seeds of the species are decidedly long-lived. Cambage (1924) has shown that the seed germinates freely after  $7\frac{1}{2}$  years' immersion in sea-water.

The following experiments at Deepwalls indicate that the seeds are capable of lying dormant until such time as they stimulated to germinate, through rupture of the testae by trampling, or softening of the testae through agency of fire:—

- (a) An area situate 10-15 yards north of a stand of "Blackwood" planted in 1912, until 1924 bore a dense 15-20 feet high thicket of *Halleria lucida*, *Rhamnus prinoides*, *Polygala myrtifolia* with a luxuriant undergrowth of *Blechnum capense*. From a 100 square yards of the area all the vegetation was very carefully removed: thousands of seeds of *A. melanoxylon* were lying either on or immediately below the soil surface, but not a single seedling occurred.

The 100 square yards were then trampled by several labourers for the space of 5 minutes, the seeds being trampled with the soil.

Within several weeks a dense regeneration of *A. melanoxylon* appeared on the trampled site.

From a second 100 square yards the vegetation was very carefully removed, but no trampling was done. Seeds of *A. melanoxylon* lay upon the soil in thousands: apart from small portions unavoidably disturbed in the clearing process, the area showed no regeneration at the end of several months.

From a third 100 square yards the vegetation was very carefully removed, and portions of the soil were fired by means of igniting spread-out brushwood: the fired soil at the end of several weeks bore a most luxuriant and dense crop of *A. melanoxylon* seedlings.

5. Regeneration of *A. melanoxylon* is *decidedly Light-demanding* and does not develop normally unless the Light-intensity is above 1/6 of full sunlight. A large number of naturally-established seedlings growing under Light-intensities of 1/12, 1/15, 1/20 have been kept under observation since April, 1924, and it has been found that these plants, although 3 to 4 years of age, still retain their *juvenile foliage* and are attenuated, whippy, etiolated, and tend to fall under the weight of their own foliar shoots.

6. Regeneration receiving sufficient light and growing in forest soil develops rapidly: plants 20 feet in height (full) by 6 to 9 inches in girth, are produced in 2 to 3 years.

7. The species sends up an abundance of "root-suckers" whenever the roots are in any way disturbed; such "suckers" may occur 30 to 60 feet away from the parent bole, and are capable of growing into normally-shaped, large trees, which in turn produce seed and "suckers."

8. The root-system of *A. melanoxylon* is extensively developed, radiating 70 to 100 feet from the boles in instances of large trees.

In view of the facts: (1) that "Blackwood" produces an abundance of seed of 90-99 per cent. viability, and "suckers" freely; (2) that the seed is dispersed to some extent by mammals and birds, and to a greater extent by water; (3) that the seed is capable of lying dormant for lengthy periods; (4) that the regeneration is very fast growing, under congenial conditions, it would seem that there is strong possibility of the species spreading considerably in time.

On the other hand the facts: (1) that the seed requires stimulating ere it will germinate; (2) that the regeneration cannot develop normally under any but strong light, argue that in normal, undisturbed forest where the degree of stimulation the seed would receive would be negligible and where the Light-intensities are usually of a low order, the degree of establishment would be insignificant. On exploitation of forest, with consequent trampling of the soil and opening up of the canopy, germination and establishment would occur wherever seeds of *A. melanoxylon* were lying in the soil. Disturbance of the ground in the vicinity of existing trees of the species would account for the appearance not only of regeneration but also of large numbers of "suckers."



The likelihood of the species spreading in the Macchia or "Fijnbos" would be slight indeed, for even when the latter is burned, slashed, grazed, or otherwise disturbed, the "Blackwood" does not thrive on the compact, acid soil, remaining stunted and unassertive.

On the whole, provided disturbance of forest in the soil of which seed of *A. melanoxylon* lies dormant, is not carried out to excess and on a large scale, there seems little danger of the species becoming uncontrollable. Willis (192) is correct in stating that native floras are not seriously influenced by exotic species unless agents of disturbance—principally the activities of man—assist the advances of the latter.

#### PROPOSALS.

*Acacia melanoxylon*, it is seen, acts detrimentally upon the seedlings of the more important forest species of the Knysna, and is a plant that might become much commoner in the region if forest containing its dormant seeds were to be disturbed. A redeeming feature is the very efficient manner in which the species kills out light-demanding and rampant weed-growth, but it can be shown that the indigenous *Virgilia capensis* acts the same part in a manner scarcely less efficient.

It is suggested, therefore, that the planting of *A. melanoxylon* within the indigenous forests be discontinued.\*

The practice of using the species as a living fire-belt is not considered sound, for the reasons that the natural processes of forest succession at the margins of the native forests are inhibited, and that the belt trees provide an abundance of seeds for dispersal in the forests adjacent to them.

It is therefore suggested that the forming of belts of *A. melanoxylon* along the margins if indigenous forests be discontinued.

From the economic point of view the planting of burnt or otherwise ruined native forest patches with *A. melanoxylon* appears sound, in that a yield of useful, saleable timber from the forests cannot be expected for several centuries at least, and in that the exotic species within half a century will produce utilisable material. On the other hand, the "Blackwoods" planted in such patches will form an important source of seed supply, and in this manner may act detrimentally upon adjacent forests of better quality.

It is suggested, therefore, that planting of burnt or ruined forest with *A. melanoxylon* should not be carried out if forest of better quality be adjacent.

#### SUMMARY.

1. *Acacia melanoxylon* R.Br., the "Blackwood," was introduced to the indigenous forests on a silvicultural scale in 1909, with the objects of killing weed-growth on exploited sites and assisting natural regeneration of indigenous species.

2. Observations showed that while the weeds were killed by the exotic, natural regeneration of tree species was either absent or poor under its stands.

3. Experiments showed that two reactions were responsible for this dearth of regeneration and for its poverty: reduced Light-intensity and reduced moisture-content of the soil, the latter being far the more important.

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\* So far as the writer is aware (1930), this was discontinued in 1927.

4. The species, while seeding efficiently and abundantly, is not likely to spread in undisturbed natural forest on account of the seed requiring stimulation ere its germination is possible, and because its regeneration is markedly light-demanding. The seed can lie dormant for many years, and thus cause the spread of the species in years to come when forest now undisturbed, is worked.

5. It is suggested that planting of the species be discontinued within the forests as well as along the margins. The planting of burnt or ruined forest is considered advisable if no better quality forest is adjacent.

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## Appendix III.

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SUMMARY OF POINTS OF PRACTICAL SYLVI-  
CULTURAL NATURE, FORESTS OF  
THE KNYSNA.



## SUMMARY OF POINTS OF PRACTICAL SYLVICULTURAL NATURE, INDIGENOUS FORESTS OF THE KNYSNA.

1. While the unexploited natural forests show, in most instances, dense stocking of large and small trees, poles, saplings, and undershrubs woody and herbaceous, resulting in *very greatly decreased intensity of light* at heights of 30 feet, 15 feet, and ground level, *high humidity of the air*, comparatively *low air temperature* and *low degree of evaporation*, regeneration of seedling, sapling, pole and small tree stages grows at an *exceedingly slow rate*. The various regeneration stages most surely will produce large timber trees in due time, but Nature's time is all too long for the forester. *The natural conditions must be improved where necessary, must be conserved where essential, cannot be depreciated with impunity.*

THE NATURAL CONDITION OF THE FORESTS, WHILE INDICATING GENERALLY THAT CONDITION WHICH THE FORESTER MUST ENDEAVOUR TO PRESERVE, MUST NOT, IN DETAIL, BE CONSIDERED AS THE IDEAL ONE FOR THE PRODUCTION OF TIMBER ON AN ECONOMIC BASIS: THE NATURAL CONDITION CAN BE IMPROVED APPRECIABLY, WITHOUT ITS FUNDAMENTAL NATURE BEING MUCH ALTERED.

2. There is a definite limit beyond which natural conditions must not be altered, if the future welfare of the forest be desired.

Experiments are showing that the natural forests are *over-dark* in most localities, that the introduction of *suitable degrees of illumination is favourable* to regeneration of all stages, in that increased increment per annum is put on, but that *introduction of excess light*—accompanied inseparably by greatly increased air temperature, insolation, evaporation, and greatly decreased humidity, *is productive of effects either merely retarding or definitely detrimental*. In like manner, competition for soil-moisture is often great during periods of local drought, young stage regeneration being either retarded or killed as the result, and while *removal of a certain proportion of the larger and smaller individuals on a unit area of ground produces beneficial results in the plants remaining, excess removal results in the appearance of dense communities of fast-growing, strongly competing weeds*, that not only fleth soil-moisture from the young regeneration, but in addition, cut down the light supply of the latter.

In a word, our treatment of the forest must be such *that undue rupture of the canopy is not brought about*. Trees to be exploited must be so selected that their removal will not result in the production of large open areas or "focus spots." These "focus spots," according to locality, soil conditions, and aspect, rapidly are invaded by such weed spp. as *Helichrysum petiolatum*, *H. parviflorum*, *Plectranthus fruticosus*, *Rubus* spp., *Cyperaceae*, and various ferns, which either prevent germination of seeds, or kill or retard regeneration. In the course of succession these weed communities are ousted by such spp. as *Cluytia pulchella*, *C. affinis*, *Halleria coppice*, *Burchellia coppice*, *Psoralea* spp., *Rhamnus prinoides*, *Nuxia coppice*, etc.—but this process takes, it is estimated from observations on various "sectioned" (or exploited) areas, from 5-20 years according to locality. Thus it is 5-20 years before regeneration gets an opportunity of either appearing, or putting on any appreciable increment.

The "weed-stage" often can be avoided altogether by refraining from marking trees in groups; occasionally it is impossible to avoid

the making of a "focus spot" (e.g. in the removal of large *P. elongata* L'Herit)—in such a contingency, rapid defeat of the "weeds," by the fast-growing *Virgilia capensis*, sown or planted as a "nurse," is advisable.

Occasionally the weed communities are either late in appearing, or may be somewhat open in structure. Regeneration (1-2 year) *in situ* is then lesioned by the excessive surface-soil temperature (140-166 deg. F.) when the exposure is a severe one, and either dies or is retarded.

3. Bearing in mind that the *canopy must be preserved wherever possible*, the following classes of *trees of saleable nature* require to be removed:—

#### *Best Species.*

Badly-shaped, damaged, diseased trees *above* the girth-limits at present in use\* . . . the so-called "*over-mature*" trees.

Such sound trees *above* the girth-limits as can be spared . . . the so-called "*mature*" trees.

Such sound and unsound trees slightly *below* the girth-limits, as are over-crowded . . . the so-called "*large immature*" trees.

#### *Inferior Species.*

Where the stocking is dense, removal of such saleable boles as will relieve the congestion, of such spp. as *Plectronia* spp., *Royena lucida*, *Olea capensis*, *Celastrus acuminatus*, *C. peduncularis*, *Elaeodendron* spp., is advisable. Better light conditions and decreased competition for soil moisture and solutes is thus brought about, provided the topmost layer is not too open.

It is a point of considerable importance that in addition to the removal of the *saleable trees*, removal of such unsaleable material as is efficient in cutting down the light-intensity and strongly competing with the regeneration of the better species, for supplies of moisture and food salts, should be carried out. Under the present system of "sectioning" *saleable material only is felled, dense stands of unsaleable spp. doing no good to the forest, being left undisturbed, together with small badly-shaped, or damaged boles of superior and inferior saleable species.* It often happens that saleable material is either scarce in or absent from a particular portion of a "section": the conditions of stocking are too dense, the light too low to allow of good increment; the portion is passed over unassisted. It is just such a portion that requires sylvicultural treatment—suitable thinning and nettoisement.

4. Even after an area has been "sectioned" and suitably thinned, it often occurs that the conditions on the ground-level are still unsuitable for the establishment of new regeneration, or the satisfactory growth of established seedlings and small saplings: dense layer-societies of *Trichocladus crispitus* ("Underbush") or of *Hemitelia capensis* ("Treefern") being the agents bringing about the unfavourable conditions. In the instance of the former plant, the prime reactions are on the light-intensity, and on the moisture of the soil, a decrease in each of these factors being the outcome; in the latter instance (*Hemitelia*), decreased light-intensity, poor soil-seriation, relatively high soil-acidity, and excessive moisture content of the soil are the unfavourable factors. Removal of, or heavy to

\* In felling practice, Forest Department, Knysna.

medium thinnings of *Trichocladus* and *Hemitelia* are followed by increased numbers of seedlings and considerably improved height-increment in established seedlings and saplings. It naturally follows that removal of these plants, in degree, depends upon the existing conditions of the upper canopy—little or nothing should be removed from open sites, while entire communities should be removed where the upper canopy is dense.\*

5. With the exception of localities rich in communities of *Trichocladus* and *Hemitelia*, the forests show from very fair to excellent regeneration in its various stages. Exploited forests rich in *Trichocladus* often show good regeneration above the *Trichocladus* even if that below this plant is poor. Transplanting of indigenous spp. of the better qualities, or sowing of seeds in exploited areas, usually, will not be found necessary, provided the "weeds" are not allowed to enter. Occasionally sowings or transplantings on sites not showing presence of seed-trees or of any established regeneration, would accelerate the production of seedling stages.

6. Coppice of Stinkwood, Wit Els, Assegaai, Hard Pear, when suitably thinned in their younger stages, produce excellent, fast-growing boles.

Stumps of these spp. should be suitably prepared after exploitation of the main boles; such gourmand-coppice as may already exist, should be thinned, so as to assist the development of the best shoots.

The best coppice is produced from shoots low on the parent-stump, and every care should be taken to assist the development of these, and to account for the removal of those placed high on the stump. Coppice should be re-thinned 2 to 3 years after the exploitation of the stumps producing the shoots.

7. When large *P. elongata* L'Herit and large *O. laurifolia*, are worked at the stump, a considerable depth and extent of chips is produced. These chip deposits may be from 6 inches to several feet in depth, and may cover from several to many square yards. Decay of the chips does not set in for several years; owing to the exudation of sap, and the rain-washings from the chips, strongly acid conditions are produced in the soil in the vicinity of the deposits. Regeneration of tree spp. is either entirely prevented from establishing itself on the deposits, or if initial establishment is successfully accomplished, the seedlings soon succumb on account of obtaining no root-hold. While weed-growth for some years is much retarded by the presence of the deposits, it ultimately flourishes on the decayed wood.

While it is realized that little good would be accomplished by removal of the smaller deposits, it is urged that steps should be taken to open up portions of the soil underlying the largest deposits, in order that regeneration might appear. In situ sowings in such cleared spots or the planting of sturdy seedlings of such spp. as *P. elongata*, *Curtisia faginea*, *Faurea Macnaughtonii*, or *Olea laurifolia* would accelerate the regeneration of such sites, on which insolation is not severe; severely insulated areas would require sowing or planting up with *Virgilia cap.*

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\* December, 1930: An inspection of some areas cleared of *Trichocladus* other woody shrubs in 1924-27 leads me to agree with Mr. Laughton that in moister sites full removal results in increased growth of such ferns as *Blechnum capense* and *B. punctulatum*. This likely is due to the increased moisture content of the soil, itself produced by removal of the water-filching *Trichocladus*.



8. While such factors as humidity, evaporation, soil acidity, and total available food salts in the soil, are known to play some part in the life-history of the forest environment, the leading rôles are played by light and soil-moisture. Experimental thinnings in the forests have shown that the girth-increment of large trees, poles, saplings is appreciably higher when suitable light-conditions are provided, than when the dark conditions of the unexploited forest occur. On the other hand, fully-exposed trees, poles and saplings may also put on good girth-increment.

The difference between the sites enjoying congenial light, suffering from poor light, or experiencing super-abundant light, is reflected more markedly in the height-increments of the trees, poles, saplings and seedlings on the several sites. Height-increment is best under the congenial conditions, is very little under the poor conditions, is only slightly greater under conditions of full-exposure. Indeed, on occasion, and according to species and conditions of the individuals, height-increment may be even less under full-exposure than it is under the darkest conditions.

Cultures of seedlings grown under controlled habitat-conditions, are showing that for the majority of the more important species, light-intensities varying from  $1/50$  to  $1/10$  (full-exposure being taken as 1), are the most congenial.

Under forest-conditions, degrees of light approximating the values above given, with a little experience, can readily be obtained.

9. So far as my experience goes, exotic plantings in the indigenous forest appear to have little useful function. "Blackwood."\* when not eaten by elephant and buck, grow rapidly, consuming large quantities of soil moisture and solutes, and react unfavourably upon the indigenous regeneration. Eucalypts have been little planted, but appear to react in much the same manner as the Blackwood. The occasional plantings of *Pinus insignis* in burned forest are not yet old enough to enable me to draw any useful conclusion concerning their merits or demerits.

For a better "nurse" crop than the indigenous *Virgilia capensis* we need not look. *Halleria lucida* is also useful, but is much slower in its rate of growth.

10. With the exception of *Ocotea bullata*, the more important indigenous species are readily raised from seed if the latter be sown in the correct manner. Transplanting of the seedlings presents little difficulty if suitable localities are selected and the weather at the time be sufficiently cool and moist; all plantings on severely exploited sites should be done under protection of a "nurse" crop.

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\* *Acacia melanoxylon* R. Br., *vide* Appendix II.

## Appendix IV.

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“A BRIEF SUMMARY OF FLORISTIC DATA FOR  
THE DISTRICTS OF GEORGE, KNYSNA,  
HUMANSDORP, AND UNIONDALE.”



## APPENDIX IV.

## A BRIEF SUMMARY OF FLORISTIC DATA FOR THE DISTRICTS OF GEORGE, KNYSNA, HUMANSDORP, AND UNIONDALE.

On account of the lack of published data concerning the prime floristic features of the country included in the Districts of George, Knysna, Humansdorp, and Uniondale, the following brief summary is of interest.

The data submitted have been compiled principally from the following sources:—

- (1) Records published in the "Flora Capensis."
- (2) Records given in S. Schönland's manuscript preliminary list of plants occurring in the Districts of George, Knysna, Humansdorp, and Uniondale. (Vols. 1, 2, and 3 of the "Flora Capensis" only.)
- (3) Records given by H. G. Fourcade in his manuscript list of plants occurring in the same region.\*
- (4) Records of plants collected by John Phillips, within the region above-mentioned.

It is desired to thank Professor Schönland for the gift of a copy of his preliminary list and for his kind assistance with the identification of numerous specimens, Dr. H. G. Fourcade for the privilege of studying his manuscript list, and the staff of the Bolus Herbarium for assistance with the identification of a number of plants.

For the larger families, e.g. Compositae, Leguminosae, Orchidaceae, Ericaceae, Gramineae, Cyperaceae, Iridaceae, Liliaceae, Geraniaceae, the numbers of species given are approximate only, there being numerous plants belonging to these families that have not been collected as yet, while a certain number of unidentified specimens are not included.

Phanerogams alone are dealt with in the summary, the data concerning the Cryptogams being too meagre as yet to warrant summarization.

## SYSTEMATIC ELEMENTS OF THE FLORA.

The Districts under description lie within the *South-Western Region* of Bolus (1886; 1905), but in reality their vegetation in many respects is different from that of typical *South-Western* nature. The *Macchia*, on the whole, is more luxuriant, the Subtropical element is more pronounced, and toward the North Semi-karroid and even Karroid conditions obtain. Despite the contentions of Schönland (1919) that the Langkloof (within the Districts of George, Uniondale, and Humansdorp) has "*an almost pure South-Western flora*," and that karroid and eastern types extend to the Cape Peninsula while certain south-western types occur together with karroid and eastern types as far as Grahamstown, the writer is inclined to agree with Rehmann (1880) and Engler (1910) in looking upon the territory between Mossel Bay on the west and Van Staden's on the east, as a region transitional between the *South-Western* and the *South-Eastern* floras.

\* By far the fullest list compiled, and containing much valuable information.

The area under description extends about 160 miles from west to east with an average width of about 35 miles, its area being roughly 6,000 square miles.

For sake of interest the *South-Western* region of Bolus is referred to also—its area being roughly 35,000 square miles. Schönland (1919) has supplied interesting data for the Districts of Uitenhage and Port Elizabeth (including portion of the adjacent District of Alexandria), to the east of the area under description, therefore these Districts too are considered; their approximate area is about 4,000 square miles.

The total† numbers of Families, Genera, and Species for the Districts of George, Knysna, Humansdorp, and Uniondale are as follows:—

	Families.	Genera.	Species.*
Gymnosperms.....	3	3	4
Monocotyledons.....	17	153	512
Dicotyledons.....	99	457	1,669
TOTALS.....	199	613	2,185

\* Native species only.

Schönland (1919:17) gives the following summary for the Districts of Uitenhage and Port Elizabeth:—

	Families.	Genera.	Species.
Gymnosperms.....	3	3	7
Monocotyledons.....	22	203	637
Dicotyledons.....	104	510	1,668
TOTALS.....	129	716	2,312

Despite minor alterations due to subsequent collections, the data submitted by Bolus (1905:215) for his whole *South-Western* Region, are of interest:—

	Families.	Genera.	Species.
Gymnosperms.....	1	2	5
Monocotyledons.....	17	155	1,301
Dicotyledons.....	92	548	4,279
TOTALS.....	110	705	5,585

The proportion of genera to species is as follows:—

+Area under discussion .....	1:3.5
Districts of Uitenhage and Port Elizabeth .....	1:3.2
South-Western Region of Bolus (1905) .....	1:7.9

The proportions of Monocotyledons to Dicotyledons is:—

+Area under discussion .....	1:3.2
Districts of Uitenhage and Port Elizabeth .....	1:2.6
South-Western Region of Bolus (1905) .....	1:3.9

† Approximate.

The families, according to the numbers of species they contain, may be listed as follows:—

Family.	Species.	Genera.	Percentage of the whole.
Compositae.....	294	72	13·4
Leguminosae.....	148	34	6·7
Orchidaceae.....	118	28	5·4
Ericaceae.....	108	12	4·9
Gramineae.....	87	39	3·9
Cyperaceae.....	86	20	3·9
Iridaceae.....	83	20	3·8
Scrophulariaceae.....	69	20	3·1
Liliaceae.....	69	20	3·1
Alzooaceae.....	61	6	2·8
Protaceae.....	51	10	2·3
Crassulaceae.....	47	4	2·2
Geraniaceae.....	45	3	2·0
Euphorbiaceae.....	45	12	2·0
Thymelaeaceae.....	43	5	1·9
Rutaceae.....	43	12	1·9
Restiaceae.....	41	9	1·9
Campanulaceae.....	39	9	1·8
Asclepiadaceae.....	34	15	1·5
Santalaceae.....	32	5	1·4
Polygalaceae.....	30	3	1·3
Umbelliferae.....	30	16	1·3
Amariyllidaceae.....	26	11	1·2
Rhamnaceae.....	25	4	1·1
Labiate.....	25	7	1·1
Gentianaceae.....	24	5	1·1
Selaginaceae.....	22	3	1·0
Celastraceae.....	21	7	0·9
Cruciferae.....	21	6	0·9
Roseaceae.....	20	6	0·9
Rubiaceae.....	20	12	0·9
Sterculiaceae.....	20	1	0·9
<i>Smaller families, as below.....</i>	—	—	17·5
			100·0
Solanaceae.....	19	5	—
Malvaceae.....	18	5	—
Oxalidaceae.....	18	1	—
Anacardiaceae.....	17	2	—
Acanthaceae.....	16	10	—
Boraginaceae.....	15	4	—
Caryophyllaceae.....	14	5	—
Convolvulaceae.....	13	5	—
Ebenaceae.....	12	2	—
Polygonaceae.....	9	3	—
Ranunculaceae.....	9	4	—
Bruniaceae.....	9	5	—
Juneaceae.....	8	2	—
Oleaceae.....	8	2	—
Sapindaceae.....	7	6	—
Myricaceae.....	6	1	—
Cucurbitaceae.....	6	3	—
Chenopodiaceae.....	6	4	—
Flacourtiaceae.....	6	4	—
Apocynaceae.....	5	4	—
Vitaceae.....	5	1	—
Zygophyllaceae.....	5	2	—
Capparidaceae.....	5	3	—
Loganiaceae.....	5	4	—
Penaeaceae.....	5	1	—
Amarantaceae.....	4	4	—
Loranthaceae.....	4	2	—
Linaceae.....	4	1	—
Haemadoraceae.....	4	3	—
Verbenaceae.....	4	3	—
Urticaceae.....	4	2	—
Myrsinaceae.....	3	1	—
Menispermaceae.....	3	2	—
Icacnaceae.....	3	3	—
Halorrhagiacae.....	3	3	—
Droseraceae.....	3	1	—
Bigoniaceae.....	3	2	—
Araliaceae.....	3	1	—
Dioscoraceae.....	3	2	—
Commelinaceae.....	3	2	—
Potamogetonaceae.....	3	2	—

Family.	Species.	Genera.	Percentage of the whole.
Portulacaceae.....	3	12	—
Plumbaginaceae.....	3	12	—
Piperaceae.....	3	12	—
Plantaginaceae.....	1	1	—
Tiliaceae.....	12	12	—
Primulaceae.....	1	1	—
Taxaceae.....	1	1	—
Aponogetonaceae.....	1	1	—
Balsaminaceae.....	1	1	—
Cunoniaceae.....	1	1	—
Dipsacae.....	12	12	—
Guttiferæ.....	1	1	—
Hamelidaceae.....	1	1	—
Lauraceae.....	12	12	—
Lentibulariaceae.....	1	1	—
Ochnaceae.....	1	1	—
Papaveraceae.....	12	12	—
Phytolaccaceae.....	1	1	—
Moraceae.....	2	1	—
Pittosporaceae.....	1	—	—
Passifloraceae.....	1	—	—
Salicaceae.....	1	—	—
Salvadoraceae.....	1	—	—
Sapotaceae.....	1	—	—
Saxifragaceae.....	1	—	—
Scheuchzeriaceae.....	1	—	—
Typhaceae.....	1	—	—
Ulmaceae.....	1	—	—
Valerianaceae.....	1	—	—
Aroidaceae.....	1	—	—
Callitricaceae.....	1	—	—
Cornaceae.....	1	—	—
Elatinaceae.....	1	—	—
Frankeniaceae.....	1	—	—
Gesneraceae.....	1	—	—
Goodeniaceae.....	1	—	—
Meliaceae.....	1	—	—
Meliastaceae.....	1	—	—
Nymphaeaceae.....	1	—	—
Oliniaceae.....	1	—	—
Musaceae.....	1	—	—
Lemnaceae.....	1	—	—
Rafflesiaceae.....	1	—	—
Cycadaceae.....	1	—	—
Pinaceae.....	1	—	—
Resedaceae.....	1	—	—

Genera represented by more than 15 species (numbers in brackets) are as follows:—

Erica.....	about	93
Senecio.....	”	50
Mesembryanthemum.....	”	50
Pelargonium.....	”	41
Helichrysum.....	”	39
Crassula.....	”	36
Aspalathus.....	”	31
Indigofera.....	”	30
Sutera.....	”	30
Thesium.....	”	25
Agathosma.....	”	25
Satyrium.....	”	25
Ficinia.....	”	24
Phyllis.....	”	22
Dios.....	”	21
Hermannia.....	”	20
Eurphobia.....	”	19
Oxalis.....	”	18
Sclago.....	”	17
Psoralea.....	”	16
Muraltia.....	”	15
Leucadendron.....	”	16

It is interesting to note that the genera with more than 15 species, in the Districts of Uitenhage and Port Elizabeth, are found among those listed above—with the sole exception of *Aloe*: *Ficinia* (23),

Mesembryanthemum (64), Crassula (49), Aspalathus (20), Indigofera (22), Pelargonium (35), Oxalis (19), Agathosma (16), Euphorbia (22), Rhus (21), Hermannia (22), Erica (30), Sutura (16), Helichrysum (40), and Senecio (59)—Schönland (1919:18).

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\* To 1926.





**“FOREST-SUCCESSION AND ECOLOGY IN THE  
KNYSNA REGION.”**

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**Maps\* showing Forest Types and  
General Geological Features.**

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**Knysna West - XXVIII.**

**Knysna Central XXIX.**

**Knysna East XXX.**

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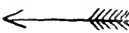
\* Maps of portion of the George District, and of the region East of the Blaauwkrantz River to the Eerste River have not been reproduced; these may be seen on application to the author.



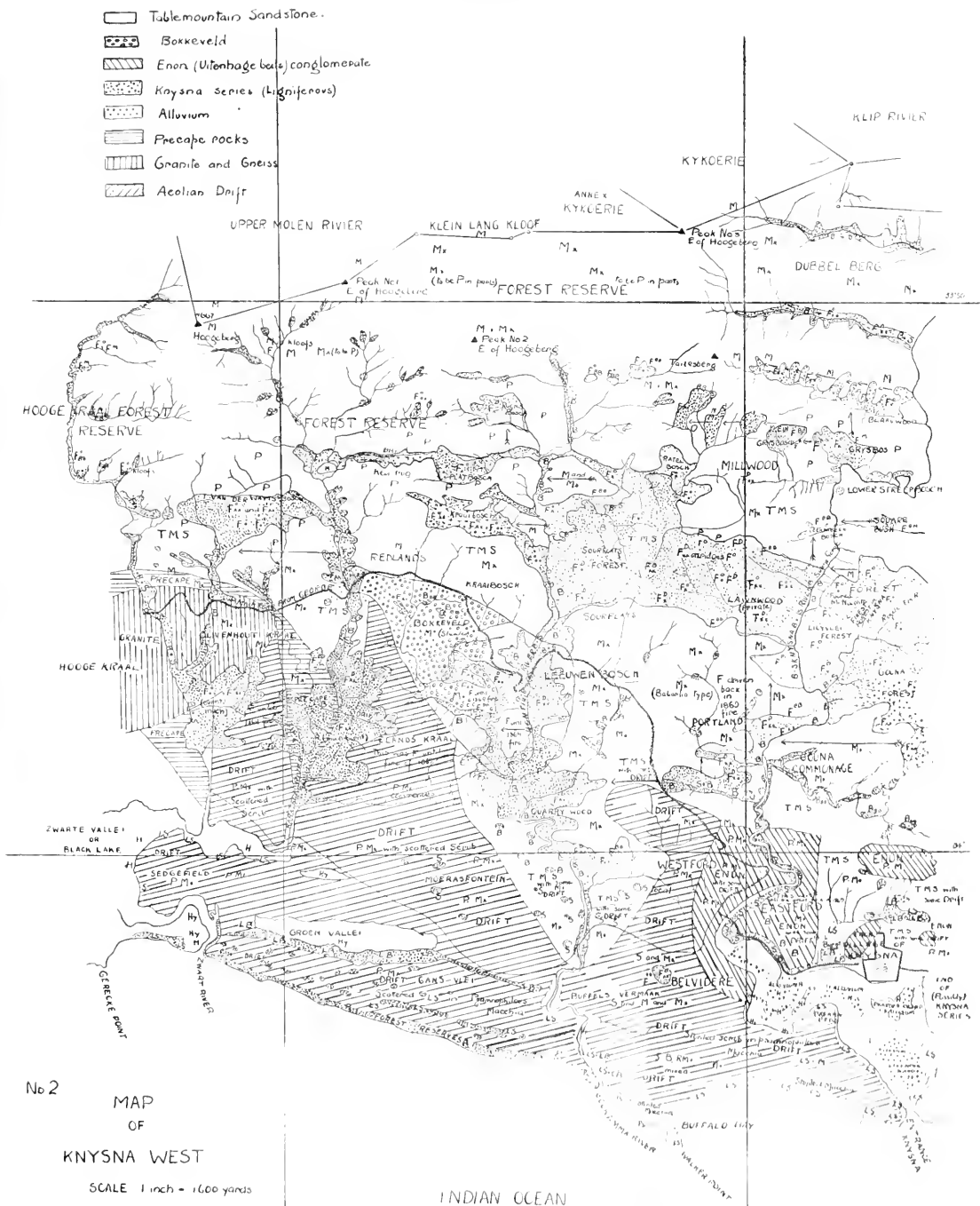
# EXPLANATION OF SYMBOLS: VEGETATION MAPS.

## KNYSNA REGION

TOPOGRAPHICAL FEATURES TRACED FROM DIVISIONAL MAPS COMPILED FROM PLANS FILED IN THE SURVEYOR GENERAL'S OFFICE. VEGETATION DETAILS BY JOHN PHILLIPS. GEOLOGICAL FEATURES LARGELY BASED UPON SCHWARZ'S WORK OF 1905 \_\_\_\_\_

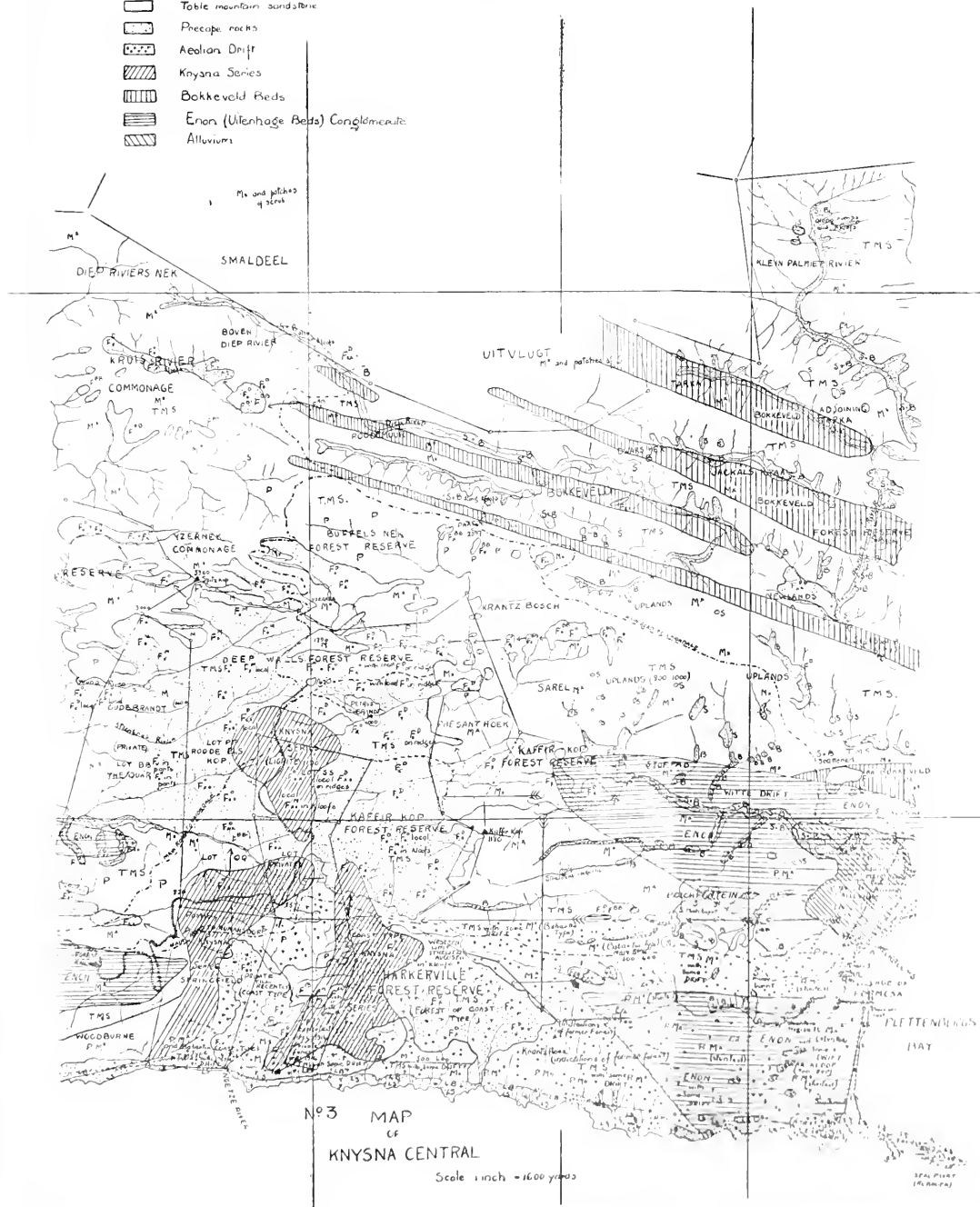
MAPS	SYMBOL	EXPLANATION OF THE SYMBOL, AND REMARKS	MAPS	SYMBOL	EXPLANATION OF THE SYMBOL AND REMARKS
(1) (2) (3) (4) + (5)	B Fv Fx Fxa F <sup>B</sup> F <sup>BB</sup>  F <sup>D</sup>  F <sup>M</sup>  F <sup>O</sup>  H. Hy L.B. L.S. M.  Mx  P.  P.Mx	BUSH. FOREST IN RELATIVELY NATURAL CONDITION. FOREST EXPLOITED. FOREST SEVERELY EXPLOITED. THIS TYPE OF FOREST IS LARGELY PRIVATELY OWNED. FOREST BURNT AND SLOWLY RECOVERING. FOREST BURNT PERIODICALLY AND GRADUALLY DECREASING IN AREA. FIRES ORIGINATING IN THE MACCHIA EITHER BY ACCIDENT OR DESIGN, YEAR AFTER YEAR, ATTACK THE MARGINS OF ISOLATED FOREST PATCHES. FOREST OF DRY NATURE: i.e. OCCURRING ON DRIER SOIL. IN THE ZITZIKANMA REGION MOST OF THE DRY FORESTS ARE ON BOKKEVELD. AVERAGE HOLARD: 25% - 30% (DRY WEIGHT) FOREST OF MOIST NATURE: i.e. OCCURRING ON MOIST SOIL. THESE FORESTS ARE FOUND PRINCIPALLY ALONG VALLEYS, IN DEPRESSIONS, AND ON THE COOL SOUTHERN SLOPES OF THE HIGHER FOOT-HILLS OF THE MOUNTAINS. AVERAGE HOLARD 100% TO 170% (DRY WEIGHT). FOREST OF MEDIUM-MOIST NATURE: THESE FORESTS ARE INTERMEDIATE TO THE F <sup>D</sup> AND F <sup>M</sup> TYPES. AVERAGE HOLARD 45% - 60% (DRY WEIGHT) INITIAL STAGES OF THE HALOSERE EXTENSIVE INITIAL STAGES OF THE HYDROSERE EXTENSIVE LITTORAL BUSH. LITTORAL SCRUB. MACCHIA: DISTURBED TO SOME EXTENT, BUT USUALLY TALL AND WELL ADVANCED MACCHIA: DISTURBED CONSTANTLY BY FIRE, GRAZING, AGRICULTURE; SELDOM ALLOWED TO GROW TALL. PLANTATIONS OF EXOTIC TREES PRINCIPALLY spp OF PINE AND EUCALYPTUS. MACCHIA OF PSAMMOPHILOUS TYPE.	(1) (2) AND (3) (4) (5)	Ps S  	INITIAL STAGES OF THE PSAMMOSERE EXTENSIVE SCRUB WITHIN RECENT YEARS THESE FORESTS WERE CONNECTED. CENTURIES AGO THESE FORESTS WERE CONNECTED.  ALL FOREST BUSH AND SCRUB AREAS TINTED PINK.







- Table mountain sandstone
- Precipitous rocks
- Aedon Drift
- Knyana Series
- Bokkeveld Beds
- Enon (Uitenhage Beds) Conglomerate
- Alluvium









(1) Initial stages of the Hydrosere:

Nymphaea stellata in foreground, Typha capensis behind. Gouw-kammia River.



(2) Initial stages of the Hydrosere:

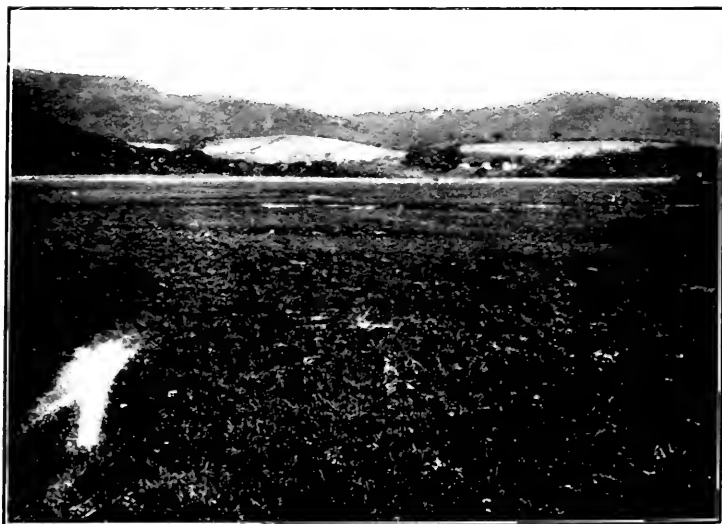
The stage of tall Cyperaceae: Mariscus riparius, Mariscus congestus, Cyperus textilis, Cladium jamaciense, Carpha glomerata, Scirpus littoralis, Eleocharis limosa, Fuirena spp., Pycreus polystachyus.

In background: Xerocline with Littoral Scrub, on left; Mesoline with Littoral Bush, on right. Noetzie River.



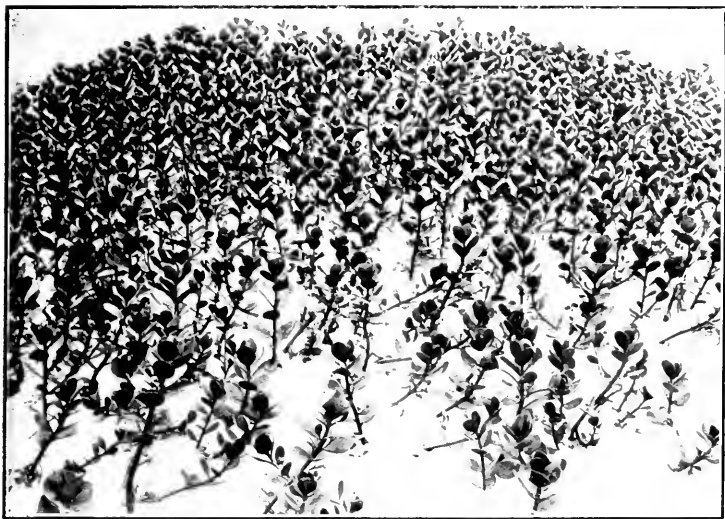
(3) Initial stages of the Hydrosere:

Cyperaceae (chiefly *Mariscus congestus* and *Cyperus tenuifolius*) and *Hydrocotyle asiatica* in centre, and the endemic *Vallota purpurea* on the margins. The *Vallota* are in flower.—Lilyvlei Forest, Gouna.



(4) Initial stages of the Halosere:

*Salicornia natalensis* consociates, *Chenolea diffusa* consociates, and *Salicornia natalensis*-*Chenolea* associates, in foreground. *Psammophilous* *Machaonia*, Littoral Scrub, and Littoral Bush in background.—Estuary of Knysna River, eastern side.



(5) Initial stages of the Psammosere:

*Scaevola (lobelia Murr.) Thunbergii* E. & Z. consociates; the plant is in flower and in heavy fruit. Note the prostrate stems, which form adventitious roots, and so fix the sand. The entire absence of plants of other species is a feature of interest.—Buffalo Bay.



(6) Initial stages of the Psammosere:

View of small dunes formed and fixed by *Scaevola*. Pioneer *Scaevola* in foreground; many of these seedlings are lesioned by the high temperature of the surface of the sand, and will die.—Buffalo Bay.



(7) Initial stages of the Psammosere:

*Scirpus nodosus* consociates on moister sand; pioneer *Stenotaphrum glabrum* is seen in the foreground. (In the background is a dense associates of *Typha capensis* and *Fuirena hirta*, standing in water.—Buffalo Bay.



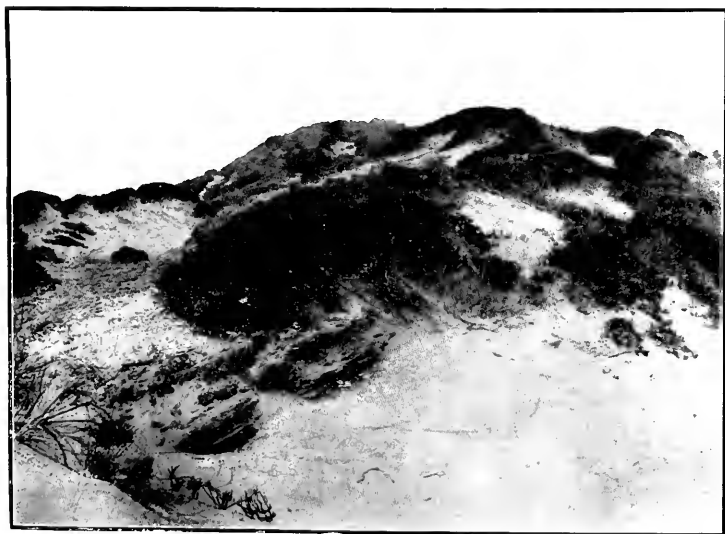
(8) Initial stages of the Psammosere:

Pioneer *Mariscus congestus* on a moister site at the base of a sand dune. The plant is stunted and sub-succulent compared with plants of the same species occurring in or near open water inland.—Buffalo Bay.



(9) Initial stages of the Psammosere:

*Cryptostemma* (*Microstephium*) *niveum* consociates; the large, heavy canescent foliage efficiently covers the sand.—Buffalo Bay.



(10) Medial stages of the Psammosere:

Stunted Psammophilous *Macchia*—principally *Metalasia muricata*, *Phytolacca lasiocarpa*, *Erica speciosa*, *Psoralea bracteata*, *Aspalathus* spp. Dune limestone formed as the result of deposition of carbonate of lime derived from shells and other remains of marine organisms, is seen in the foreground.—Buffalo Bay.

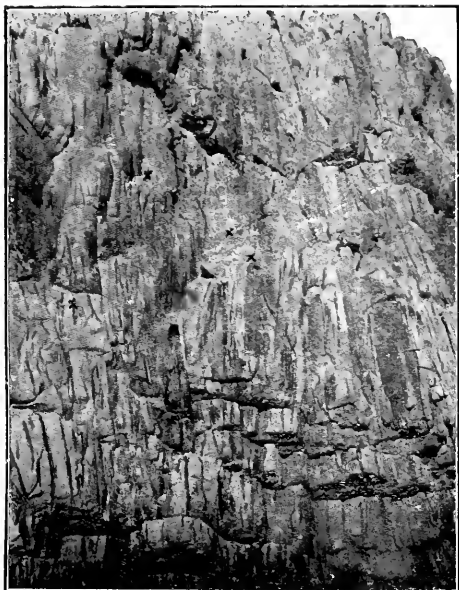


(11) General view of the coast immediately west of the Groot River, Knysna district, showing the row of littoral dunes bearing *Psammophilous Macchia* and Littoral Scrub on their crests, and Littoral Scrub and Littoral Bush on their landward slopes. Much of the Littoral Bush has been cleared for agricultural purposes. Burnt *Macchia* rich in *Aristea* and *Gladiolus* in foreground.



(12) The Psammosere inland:

In foreground: *Mesembryanthemum edule*, *M. acinaciforme*, *Othonna amplexicaulis*, *Rubus rigidus*, on white sand derived from Bokkeveld and Table Mountain beds adjacent. In background, mixed *Psammophilous Macchia* and Scrub species.—Roosmuur, district Knysna.

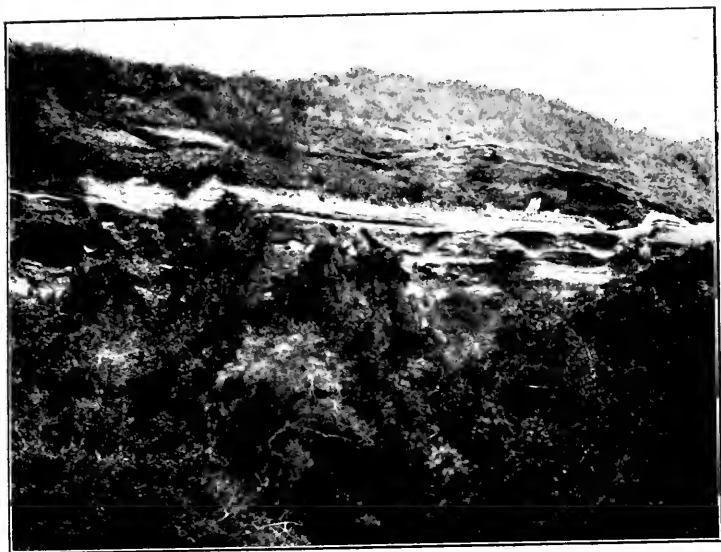


(13) The Lithosere at the coast; at the x's are pioneer plants of *Gazania uniflora* finding slender roothold in the crevices in the faces of the sheer, rocky cliffs.—Coast immediately east of the Noetzie River. The rocks are of Table Mountain Sandstone.





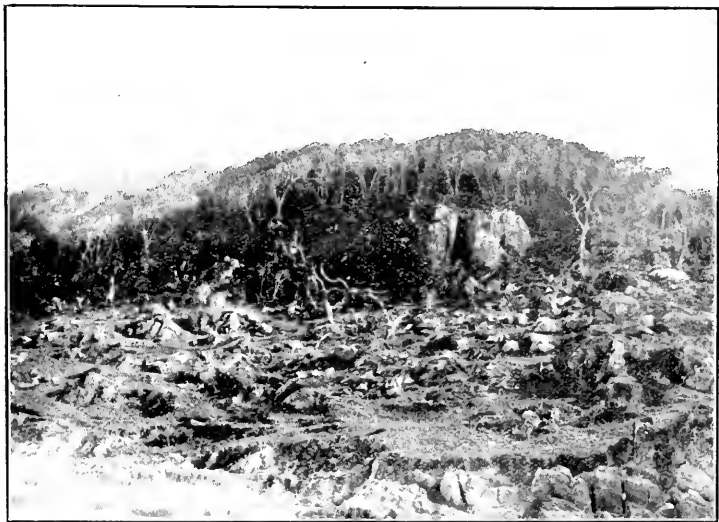
- (14) Lithophilous vegetation, Xerocline, Noetzie River. The rocky sites in the centre are held by *Crassula perfoosa*, *C. platyphylla*, *C. rubricaulis*, *C. rosularis*, *C. clavifolia*, *Cotyledon orbiculata*, *Senecio juncus*, *Helichrysum paniculatum*, *Gazania uniflora*, *Asparagus africanus*. Above is Scrub, below Bush, and in the foreground, Hydroseral stages—*Phragmites* and *Cyperaceae*.



(15) Lithophilous *Macchia* on Enon conglomerate; Bush below the white beds.—Eastford, Knysna.



(16) Rocky hillside, Rooimuur, Lithophilous *Macchia* (including spaces of *Themeda triandra*) and scattered *Aloe ferox* on right, and Inland-type Scrub on left.



- (17) Littoral Scrub, within 300 yards of sea, Noetzie. The principal species forming the community are *Elaeodendron Kraussianum*, *Sideroxylon inerme*, *Plectrocnia ventosa*, *Pterocelastrus variabilis*, *Olea capensis*, *Tarconanthus camphoratus*, and stunted *Podocarpus elongata* and *P. Thunbergii*, the undergrowth consisting of *Knowltonia* spp., *Hypoestes* spp., and *Aspidium capense*. In foreground, site of cleared Littoral Scrub, with *Stenotaphrum glabrum* dominant, and scattered *Knowltonia glabricarpellata*. The Scrub is 8 to 12 feet in height.



- (18) Littoral Scrub—margin 20 feet above the sea. *Elaeodendron Kraussianum* on left, *Pterocelastrus variabilis* on right, with tangle formed by *Ficus capensis*, *Capparis citrifolia*, and *Sentia Commersonii*, in centre.—Noetzie.



(19) Littoral Scrub: *Sideroxylon inerme* in foreground, much malformed by sea winds; behind, mixture of *Pterocelastrus variabilis*, *Acokanthera venenata*, *Doyvalis rhampoides*, *Olea exasperata*, and other spp.—Buffalo Bay.



(20) Littoral Scrub: interior, with *Sideroxylon inerme* in foreground; note the open, dry nature of the ground.—Buffalo Bay.



(21) Inland Scrub and Bush, along river valleys, and Scrub and Lithophilous Macchia on the ridges. Outeniqua-Zitzikamma range in distance.—Near Uitvlugt.



(22) Scrub in foreground merging into Bush in background. The large tree is *Podocarpus elongata* L'Herit. of full height, 35 feet. In foreground are *Aloe arborescens*, *Myrsine melanophlebos*, *Rhus lucida*, *Pterocelastrus variabilis*.—On Eastford Estate.



- (23) Littoral Bush: Interior, on an exposed, shallow-soiled ridge within  $\frac{1}{2}$  mile of the sea. Grotesque *Podocarpus elongata* L'Herit., of girth (at  $4\frac{1}{4}$  feet from ground) 14 feet, its bole being 6 feet in length only; the height to the top of the crown is 30 feet. The tree is a female which fruits profusely, but absolutely no regeneration has been found near it. The associated species are principally *Elaeodendron Kraussianum*, *E. capense*, *Euclea macrophylla*, *Plectronia ventosa*, and *Trichocladus crinitus*.—Harkerville Reserve.



(24) Littoral Bush: Interior, in a well-protected, deep-soiled position. *Podocarpus elongata* L'Herit., 5 ft. by 35 ft., in centre; note the flattened nature of the branches—the influence of the sea-winds. A small *Myrsine melanophleas* appears to the right, and behind it a second *P. elongata*. The lianes are *Rhoicissus capensis*, *Cissus cuneifolia*, *Scutia Commersonii*, *Secamone Alpini*, *Cynanchum* spp., *Pyrenacantha scandens*, and *Clematis Thunbergii*. On the ground are *Haemanthus puniceus* and *Hypoestes aristata*.—Harkerville Reserve.





(25) Littoral Bush: interior. *Elaeodendron Kraussianum*, *Plectronia ventosa*, *Myrsine melanophlebos*, and stunted *Podocarpus Thunbergii* Hook. Regeneration very sparse.—Harkerville Reserve.



(26) Inland Bush: interior. *Pterocelastrus variabilis*, *Myrsine melanophlebos*, *Plectronia obovata*, and *Trichocladus crinitus*. Regeneration very sparse.—Harkerville Reserve.



- (27) Forest of coastal type on left (rich in *Podocarpus* spp., *Olea laurifolia*, *Elaeodendron croceum*, *E. Kraussianum*, *Rhus laevigata*, *Calodendron capense*, *Ekebergia capensis*, *Celtis rhameifolia*) and Scrub and Bush on right—the Scrub covering all but the most sheltered and the best-soiled positions. The left slope experiences a S. E. aspect, and is the *mesocline*; the right slope experiences a N.W. aspect and is the *erocline*.—Along the Noetzie River.



- (28) Forest of coastal type; this forest was exploited in 1918-1921 and yielded some good timber (*Podocarpus* spp., *Olea laurifolia*, *Elaeodendron croceum*, and *Myrsine melanophleas*) despite the short height-growth of the trees. *Phragmites communis* and *Scirpus littoralis* along the margins of the river.—Noetzie.



- (32) Forest of medium-moist type, with *Trichocladus crinitus* layer removed; the trees are principally *Podocarpus Thunbergii* and *Olea laurifolia*, while the regeneration is mainly that of *Ocotea bullata* and *Podocarpus Thunbergii*. *Blechnum punctulatum* fronds in central foreground, those of *B. capense* on right.

The light-intensity below the removal of the *Trichocladus* was  $1/300-1/400$  at ground-level, at noon on clear days; after removal it was  $1/20-1/40$ . Regeneration has improved since the removal of the shrub.



- (33) Forest of medium-moist type, where *Trichocladus crinitus* is not so dense, its place being taken by tall *Blechnum capense* (see fronds in foreground). Note the abundant pole regeneration of various species, principally *Podocarpus Thunbergii* and *Ocotea bullata*. Owing to the abundant *Blechnum* there are few young seedlings on the ground.—Deepwalls.



- (34) Forest of moist type, the *Hemitelia capensis* layer being removed so as to assist regeneration of the area. Several *Hemitelia* are seen. The large tree (made up of 6 gourmand-coppice shoots) is *Ocotea bullata*, those trees to the left are *Cunonia capensis*. Owing to the strong reaction of the *Hemitelia* on the light-intensity (cutting down the light at ground-level to  $1/800$ – $1/1500$  at noon on bright days) there is practically no regeneration of tree species on the ground. Removal of the fern increases the light-intensity 8- to 12-fold.—Vanhuyssteenbosch.



- (35) Forest of moist type: boles of small individuals of *Platylophus trifolius* in centre; *Hemitelia capensis* layers left and right—the fern has been removed from the centre to enable the photograph to be taken. The upright poles are truncheon-cuttings of *Platylophus*. The mean holard at 6-12 inches, under the ferns, is 170% on dry weight; the light-intensity under the ferns at midday is 1/1200; the pH value for the soil solution is 4.4. Regeneration is absent.—Deepwalls.



(36) Better class montane forest of moist type: *Cunonia capensis* in foreground, *Platylophus trifoliatus* in back. Note the dense layers of *Hemitelia capensis*, *Marattia fraxinea*, and *Todea barbara*. Under the ferns the conditions are exceedingly moist, acid, and dark. Regeneration is sparse.—3,200 ft. Deepwalls.



(37) The establishment of communities of *Virgilia capensis* on burnt sites; note the numerous seedlings (7 days old) on 1 square-metre of burnt soil.—Deepwalls. (The hard seed of *Virgilia* may remain dormant for many years if not stimulated to germinate by heating or bruising.)





(38) 34 years old consociates of *Virgilia capensis*, along the burnt margin of climax forest. The trees are 12-18 feet high and 4 to 8 inches in girth at breast-height. Under canopy of the *Virgilia* seedlings of the forest trees proper, appear, and grow vigorously. Slashed fire-belt in Macchia, in foreground.



- (39) *Virgilia capensis consociata*, 3-4 years old. Note the dead and dying *Thamnochortus racemosus* and *Pteridium aquilinum* under cover of the tree. The banded trees are under observation for the collection of girth-increment data. *Virgilia* trees at this stage grow at the rate of  $\frac{3}{4}$  to 1 inch per annum (girth).



(40) Natural re-establishment of forest on burnt sites, through agency of *Virgilia capensis*. *Virgilia* in background, *Helichrysum petiolatum*, *Pteridium aquilinum*, and *Cliffortia odorata*, in foreground. Under the *Virgilia* are numerous seedlings of tree species; on the weed-clad area, no seedlings occur.



(41) *Virgilia capensis* forming a large and close consocieties; the trees appeared after a forest-destroying fire, in 1911.

Their average height is 45 feet, and their girths range from 6 inches (suppressed) to 36 inches (dominant). Under their canopy are hundreds of seedlings of *Podocarpus Thunbergii*, *Curtisia faginea*, and other spp. Relict patches of *Helichrysum petiolatum* and *Rubus fruticosus* (exotic) remain, but do little harm to the young trees.—Gouna.



(42) A site cleared of *Gleichenia polypodioides* Sm. and then fired; in the soil, seed of *Virgilia capensis* had lain dormant over 30 years; several weeks after the fire thousands of seedlings of this tree appeared on the ground—*vide* foreground.—Deepwalls.



(43) *Olinia cymosa* consociates, with abundant regeneration of *Podocarpus Thunbergii* Hook in background.—Deepwalls.



(44) The giant crowns of *Podocarpus elongata* L'Herit.; the trees are growing in a deep ravine.—Grootriver.



(45) A small consociation of *Ocotea bullata*; the ground flora consists of *Pteridium aquilinum* and *Plectranthus fruticosus*. Scattered *Ocotea* consociations are not uncommon along roadsides.



- (46) Gourmand-coppice of *Ocotea bullata*; the shoots in time form their own roots and become independent of the main stem, which often dies back on establishment of the coppices.

The lianes are *Clematis Thunbergii*, *Secamone Alpini*, and *Ficus Burtt-Davyi*. In foreground, dense *Pteridium aquilinum* and *Plectranthus fruticosus*.—Deepwalls.

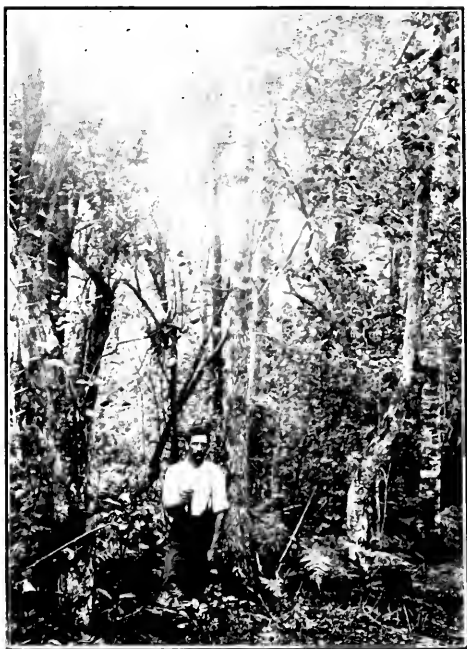


(47) *Podocarpus Thunbergii*—*Olea laurifolia*—other spp. association, with scattered *Faurea McNaughtonii*. The central bole is that of *Faurea*.—Lilyvlei Forest, Gouna.



(48) *Podocarpus Thunbergii*—*Olea laurifolia*—other spp. association; excellent natural regeneration of *Podocarpus Thunbergii* in foreground.—Deep-walls.





- (49) *Podocarpus Thunbergii*—*Olea laurifolia*—other spp. association, showing *Nuxia floribunda* on left, *Gonioma Kamassi* in the centre, *Apodytes dimidiata* on the right, and dense *Trichocladus crinitus* in the background. The liane ascending the bole of *Nuxia* on the left is *Pyrenacantha scandens*. Regeneration of tree species is locally frequent.—Deepwalls.



(50) *Podocarpus Thunbergii*—*Olea laurifolia* association. Bole of a large *Olea* is seen on the right, bole of a *Podocarpus* on left. The open nature of the community in the foreground, is due to cattle trespass. The pole stages are principally composed of *Podocarpus Thunbergii* regeneration. —Deepwalls.



(51) *Podocarpus elongata* L'Herit. Girth at 4½ feet, 14 feet; height of clear bole, 60 feet; full height, 120 feet—a relict tree in climax forest, its fellows being felled.—Deepwalls 1,400 feet.



- (52) A 1 square-metre quadrat set out on the floor of a *Podocarpus Thunbergii*—*Olea laurifolia*—other spp. association; there are over 400 2-year-old *Olea laurifolia* seedlings on the quadrat, as well as numerous plants of *Impatiens capensis*, *Carex aethiopica*, and *Juncus lomatophyllus*.

The majority of the *Olea* seedlings will succumb to the ravages of fungi (*Microthyriaceae*, *Perisporiaceae*, and *Corticium vagum*) and insects (*Coccidae*).



(53) A felled *Podocarpus elongata* L'Herit., showing the high degree of damage caused by its fall; the widespread and heavy crowns break down numerous trees, and pile up branchwood over 10 feet in depth; regeneration of forest trees is unable to establish itself on such sites for periods ranging from 5 to 20 years.—Climax Forest, Deepwalls, 1,500 feet.



- (54) A common feature of the forest floor on exploited sites—an extensive (sometimes 20 to 50 feet square) and deep (6 inches to 4 feet) layer of chips covers the soil. The chips prevent the establishment of weeds, but also of seedling trees. The soil under such chip layers is usually highly acid (pH 4.9–pH 4) owing to the washing out of organic matter in the chips. Chips of *Olea* yield more acid washings than those of *Podocarpus* spp.



(55) Subseral communities, exploited forest: Left to right: *Plectranthus fruticosus* (in flower) consociates, forming a dense growth about 8 feet high; *Cluytia pulchella* consociates forming an opener community, 10 feet high. The insolation above the communities (noon, October, 1924) is severe, but the light-intensity *under* the *Plectranthus*, at ground-level, is  $1/450$  only; under the *Cluytia* it is  $1/180$ .—Sourflats Forest, 1,500 feet. ( $2\frac{1}{2}$  years after removal of top canopy.)



- (56) Subseral communities, exploited forest: Left to right: Shoots (coppice) of *Halreria lucida* and *Burchellia capensis* 8 to 12 feet high; dense consociates of *Plectranthus fruticosus* 9 feet high; tangle of *Rubus fruticosus* (exotic) on extreme right.—Deepwalls Forest, 1,400 feet. (4 years after removal of top canopy.)





(57) A subseral community of *Osteospermum moniliferum* appearing on a site from which the top canopy was removed 9 months previous. The plants are  $2\frac{1}{2}$  to 4 feet high, and under their cover seedlings of *Olea laurifolia* and *Podocarpus elongata* are already appearing.—Harkerville Forest, 700 feet.



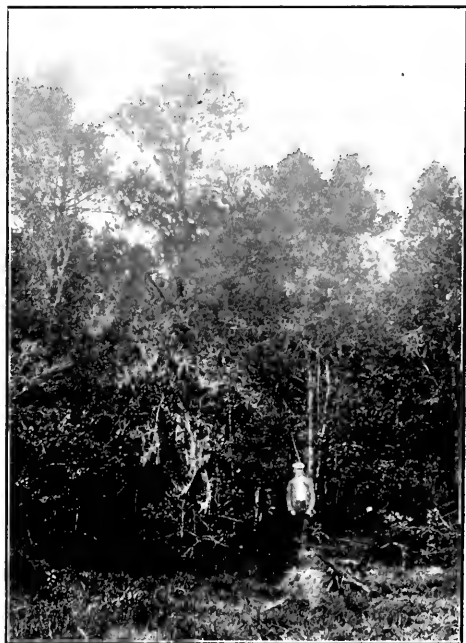
- (58) Weed-communities on a site from which the canopy was removed 3 years previous. The principal plants (left to right) are *Helichrysum petiolatum* (white), *Mariscus congestus*, *Plectranthus fruticosus*, and *Rubus pinnatus*; on the extreme right, the fronds of a relict *Hemitelia*. The weed-growth is 36 inches deep, and is very dense; despite sowings of "seeds" of *Curtisia*, *Olea*, *Elaeodendron*, not a single tree seedling is to be found under the dense cover. The light-intensity at ground-level at noon is  $1/800$ .—Sourflats Forest, 1,600 feet.



- (59) Colonization of a heavily felled site, Climax Forest, by *Helichrysum petiolatum* (white) and *Chrytia affinis*—2 years after removal of canopy. Examination of this site (*vide* transect tape) showed that no tree seedlings had appeared, and that those that occurred on the ground prior to removal of the canopy, had been lesioned to death by the severe temperature of the surface soil.—Deepwalls Forest, 1,500 feet.



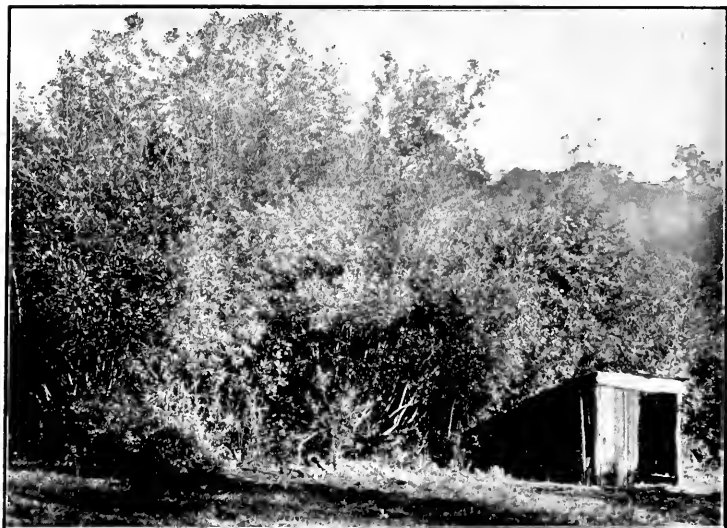
(60) Moist type forest, Deepwalls, 3 years after heavy felling: In centre, shoots of *Halleria lucida* 10 feet high; on extreme right, *Sparmannia africana* 8 feet high; the white weed profusely developed throughout, is the rampant *Helichrysum petiolatum*. Examination of quadrats on this area showed that no tree seedlings existed; the light-intensity at ground-level ranges from  $1/200$  to  $1/600$ .



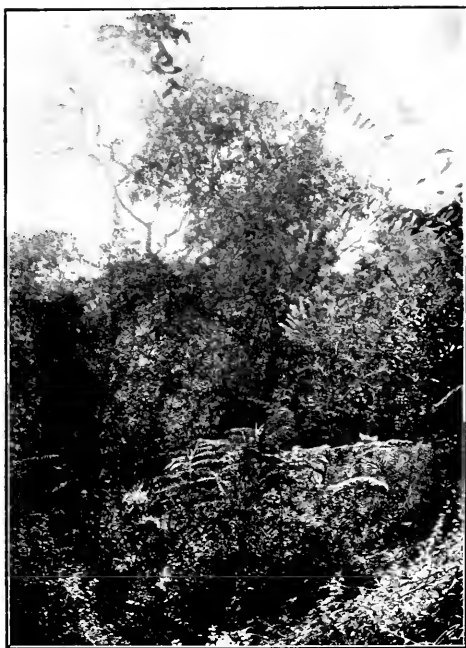
(61) Conversion of forest to bush by means of long-continued exploitation: the *Podocarpus Thunbergii* seen are 35-40 feet high; the general mass is made up by *Myrsine melanophleas*, *Olea capensis*, *Pterocelastrus*, and *Trichocladus crinitus*.—Church of England Forest, Harkerville.



- (62) Conversion of forest to bush by means of sudden clear felling. The dominants are stunted *Podocarpus* spp., *Peterocelastrus variabilis*; shoots of *Halleria*, *Rhamnus*, and *Burcellia*. *Helichrysum petiolatum* (white) forms extensive and dense communities inhibiting the establishment and development of tree seedlings.—Forest Creek Mining Concession (extent 20 acres)—16 years after felling.



(63) The rôle of coppice—a small *Platylophus trifoliatus* consociates re-establishing itself by means of coppice, 16 years after clear-felling of the main boles.—The general height of the coppice is 30 feet.—Forest Creek Mining Concession.



(64) Portion of forest exploited severely and burnt 70 years previous; *Halleria fucida*, *Burchellia capensis*, *Pteridium aquilinum*, and *Helichrysum* spp. Scattered seedlings and saplings of forest trees appear.





- (65) Medium-moist type climax forest, Sourflats, showing a clear-felled strip 22 yards wide, running through it.

The photograph is instructive in that it contrasts the dark forest on either side of the strip with the brightly illuminated clear-felled strip. Although  $2\frac{1}{2}$  years only have elapsed since the removal of the canopy, the felled strip is clad to a height of 4 to 10 feet, with dense *Helichrysum petiolatum*, *Plectranthus fruticosus*, *Rubus fruticosus*, *R. pinnatus*, and *Cluytia* spp. *Halleria* and *Burchellia* shoots are frequent. Seedlings of tree spp. are almost entirely absent, and quadrats provided with selected "seeds" of forest spp. have produced no plants.



- (66) Moist type forest, Deepwalls: Site of a moderate felling. Under canopy, at breast-high, the light-intensity at noon is  $1/200$ – $1/100$ , while under full exposure on the felled site it is  $1/2$  to  $1$ . The temperature, however, on small felled sites is not a limiting factor. *Cluytia* spp. and *Curtisia faginea* seedlings are seen in the right foreground.



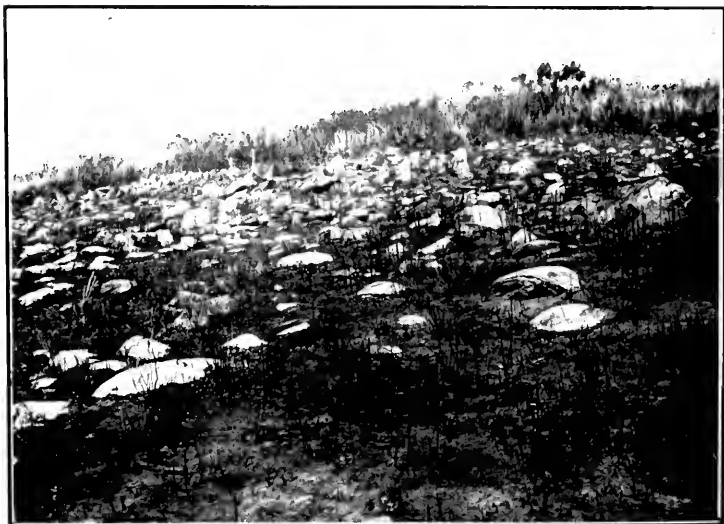
(67) Freshly exploited forest, showing disturbed nature. The canopy was removed just before the taking of the photograph. Stems of *Podocarpus Thunbergii*, *Olea laurifolia*, and *Apodytes dimidiata* are seen from left to right. The insolation at the surface of the soil is severe—numerous lesioned seedlings of *Myrsine*, *Curtisia*, *Podocarpus* spp., and *Olea laurifolia* were found—January, 1925.—Harkerville Forest.



- (68) Freshly exploited forest, showing disturbed nature. Owing to the presence of a stump of *Platylophus* bearing coppice (on left) this site will, within a few years, be healed. Until such time, the *Osteospermum moniliferum* seedlings already present (several weeks after felling ceased) will do much to prevent insolation doing damage to any tree seedlings that may appear.

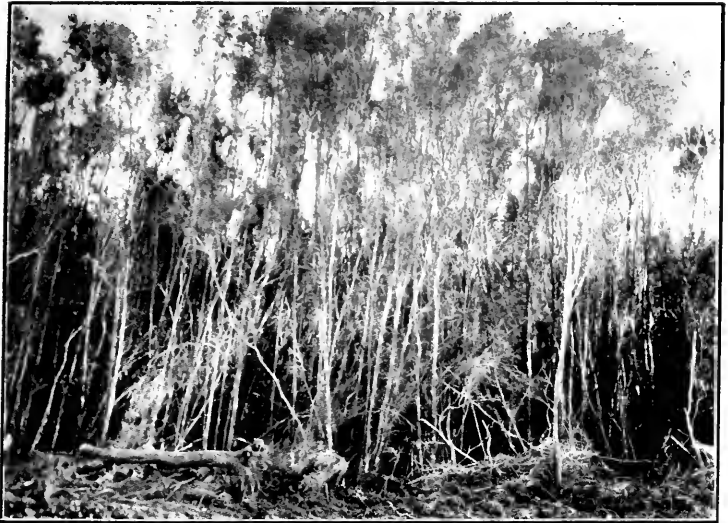


(69) *Widdringtonia cupressoides* scattered in hygrophilous Macchia. The trees, owing to constantly-recurring fire in the Macchia, are but 5 to 10 feet high.



(70) Fired Macchia immediately after the fire. Such sites lose considerable amounts of soil during winds and heavy rains as the surface soil is quite unprotected. The burnt roots of *Berzelia*, *Brunia*, *Penaea*, and *Leuca-dendron* seen will all re-shoot.

It was on the site photographed that some of the studies recorded on pp. 21-22, Chapter I, were carried out.—Deepwalls, 1,600 feet.



- (71) Hygrophilous Macchia that has not been burnt for about 25 years. The principal spp. are *Brunia intermedia*, *Empleurum serrulatum*, *Erica canaliculata*, *E. speciosa*, *Leucadendron eucalyptifolium*. Under canopy at ground-level) of the tall shrubs the light-intensity at noon ranges from  $1/250$  to  $1/800$ ; numbers of seedlings of tree spp. (especially of *Myrsine*, *Plectronia* spp., *Royena* spp., *Pterocelastrus*, *Celastrus* spp.) are to be found on every square metre, but most of these succumb owing to the dark conditions and the lack of aeration.—De Merk Harkerville, 600 feet.



(72) Within the above community: The general height is from 12 to 20 feet; the girths of the larger shrubs range from 5 inches to 12 inches. A clearing was made for purposes of photography.

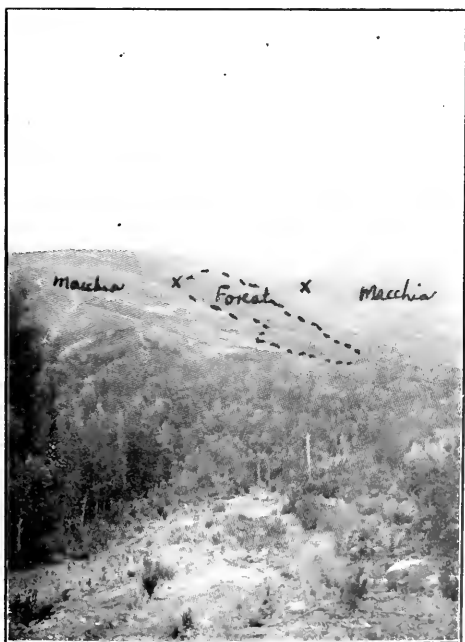


(73) Dispersal of seed by the Knysna elephant: The large-leaved plants seen are *Solanum giganteum*, the seeds of which are carried by the elephant. On the death of the animal, the bones of which are seen, the seeds germinated and formed the small *Solanum* community.—Deepwalls, 1,400 feet.





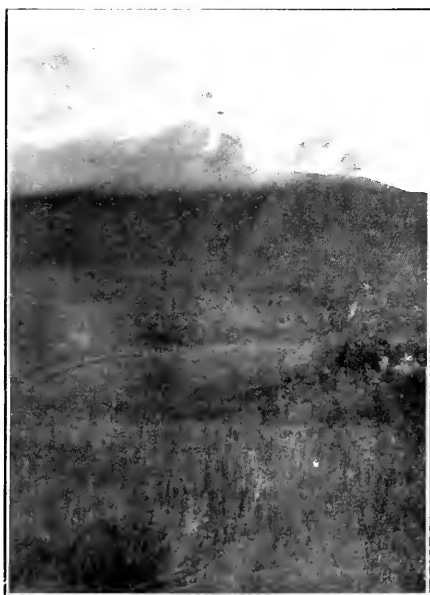
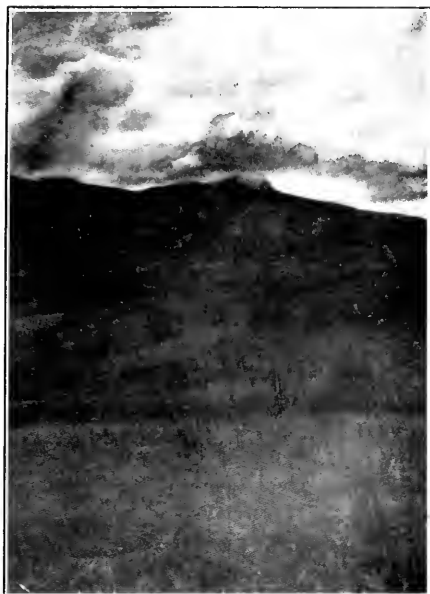
- (74) The ladder on the northern aspect, Deepwalls Hill; this ladder is referred to on page 40, Chapter 2, and the data collected from it are summarized in Table VII. A similar structure was used on the southern aspect. The uppermost screen is 40 feet above the ground, the middle one, 20 feet, and the lowest (not seen), 6 inches above the ground.



- (75) Retreat of the forest before fire; from an examination of the ground it is clear that the relict patch of forest sheltered in the moist valley seen in the centre of the photograph, x at one time was surrounded by forest. The Macchia on all sides of the patch yields direct evidence of being subseral only.—Buffelsnek, 1,700 feet.



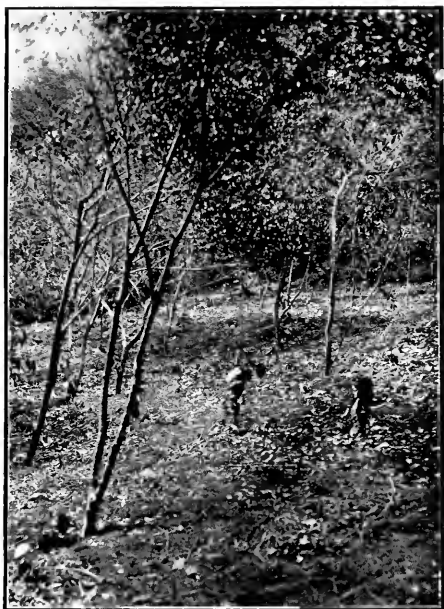
(76) A forest relict; 10 years ago this patch was many times larger than shown in the photograph (1923), but constantly occurring fires in the Macchia have accounted for its diminution.—Rondebosch, 1,800 feet.



(77), (78) Hydrometeoric Mists or "Nebelreissen" (*vide* Chapter II) on higher sites, Deepwalls. First Dawn. These mists deposit much moisture upon the foliage of the Forest trees and a certain amount upon that of taller Macchia.



(79) Bole of young *Ocotea bullata* E. Mey. ("Stinkwood"), showing white band used in study of the girth-increment.



- (80) Method of raising insolation-tender seedling trees (*Ocotea bullata*, *Curtisia faginea*, *Apodytes dimidiata*, *Platylophus*, *Cunonia*): Branches of shrubs are placed in the ground so as to shield the young trees; the light-intensity is cut down  $1/5$ – $1/20$ , and the soil-temperature at the surface is much decreased.



(81) *Acacia melanoxylon* R.Br. (Tasmanian Blackwood) planted in exploited forest, in 1912. 1921: Height 50-60 ft. This sp. reacts strongly on the Holard (*vide* Appendix II).



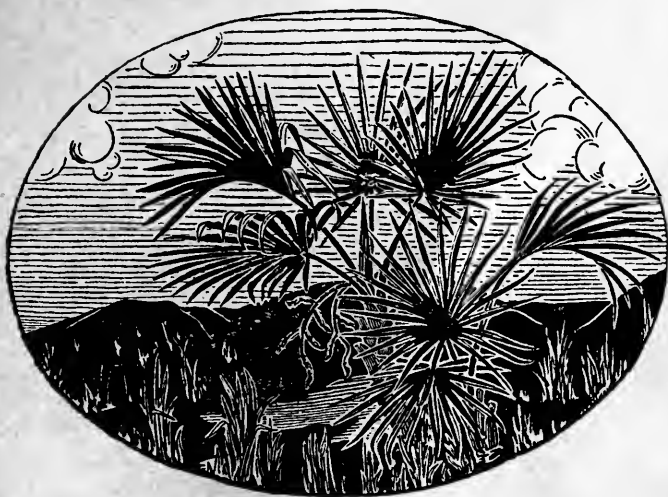
(82) *Acacia melanoxylon* R.Br., 2 years old, exploited forest. Such are much sought for food by the elephants. Several in the foreground show broken crowns (*vide* Appendix II).

# BOTANICAL SURVEY OF SOUTH AFRICA

MEMOIR No. 15

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## A VEGETATION MAP OF SOUTH AFRICA



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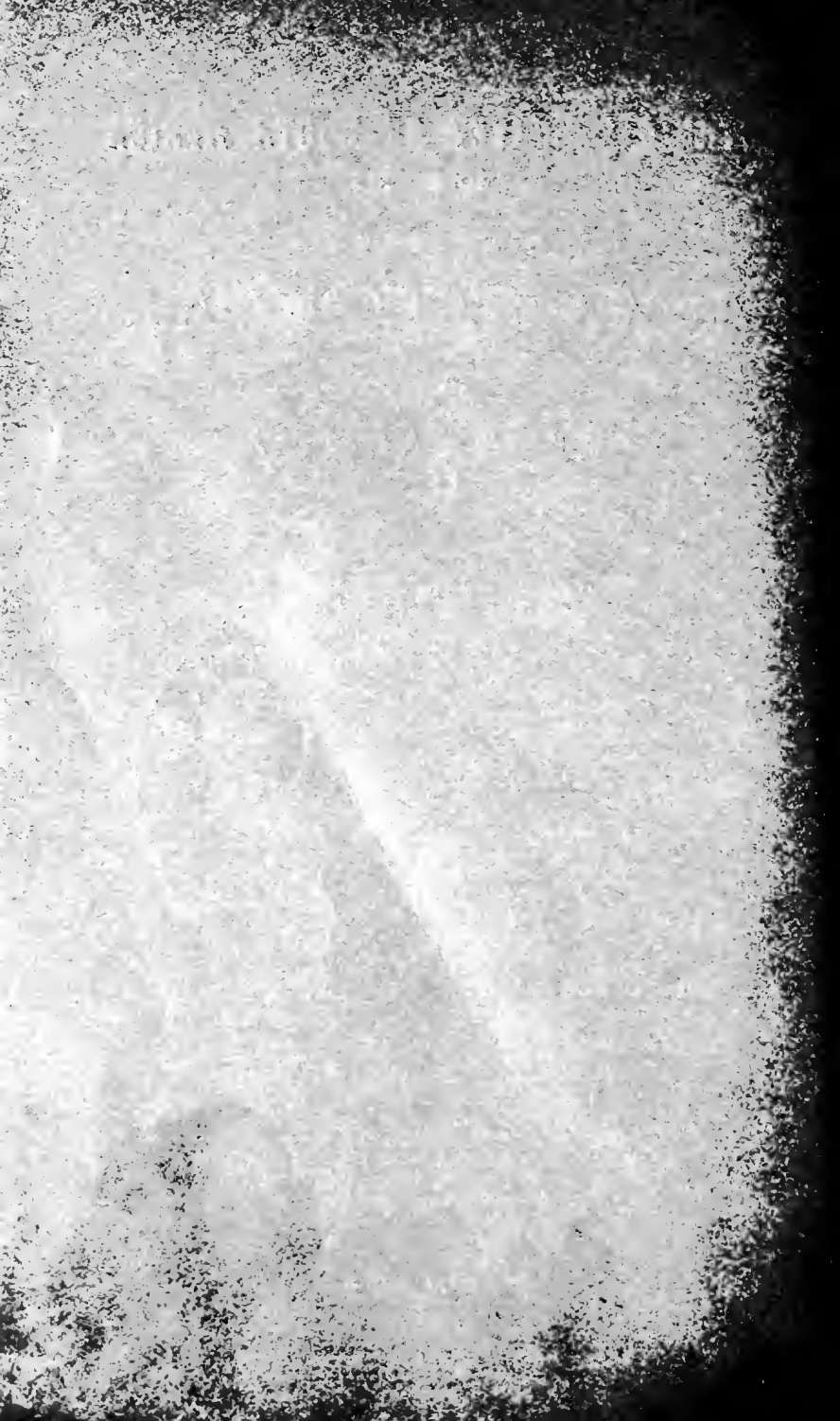
By I. B. POLE EVANS, C.M.G., M.A., D.Sc., LL.D., F.L.S.  
Director of the Botanical Survey of the Union of South Africa

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UNION OF SOUTH AFRICA

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DEPARTMENT OF AGRICULTURE AND FORESTRY

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# BOTANICAL SURVEY OF SOUTH AFRICA

MEMOIR No. 15

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## A VEGETATION MAP

OF

## SOUTH AFRICA

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## FOREWORD.

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THE official yearbooks of the Union of South Africa have from time to time contained vegetation charts of the country, all of which have shown considerable variation from the first one. This variation has been due to the fact that the accumulation of more and more knowledge has made it possible to delimit with more accuracy the extent and distribution of the various types of vegetation.

The Botanical Survey of the Union was established in 1918, and one of its main objects was to study and map the South African vegetation units, and to investigate the conditions which influence them. Since 1918 considerable work in this direction has been carried out by the survey, and it is now possible to delimit with greater accuracy these vegetation units, especially in the north-eastern portion of the Union, where much of the work of the survey has been concentrated. The present map brings much of this work up to date, and it is hoped that it will now serve as a basis for further detailed investigations.

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PRETORIA, 17TH JULY, 1935.



# A Vegetation Map of South Africa.

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The Union of South Africa occupies the southern portion of the great African Continent. It lies between latitudes  $22^{\circ}$  and  $35^{\circ}$  south. On the north it is bounded by South-West Africa, the Bechuanaland Protectorate, and Southern Rhodesia, and on the north-east by Portuguese East Africa. Its shores on the west are washed by the cold Atlantic ocean, and on the south and east by the warm Indian ocean. The area of the Union is 473,000 square miles, or 300,000,000 acres, approximately four times the size of Great Britain.

The Union is on the whole a high-lying country, as some forty per cent. of the area is within the 4,000 ft. contour. The country is divided by a well marked escarpment into a great interior plateau and a much diversified tract of country lying between the escarpment and the oceans on the east, on the south, and on the west. The highest parts of the country are on the escarpment or in its neighbourhood, especially on the east, where the highest point reaches some 10,880 feet.

The rainfall of the Union is greatest in the east and decreases towards the west. Over the eastern portion it varies from 50 inches in some parts to 15 inches in others, and over the western portion from 20 inches down to under 5 inches. Three well-marked rainfall areas occur:—(1) A region of summer rainfall which includes the greater part of the country: (2) a region of winter rainfall which covers a comparatively narrow strip of country at the south-western extremity of the sub-continent, and (3) a constant rainfall region confined to a much smaller belt on the south coast. The greater portion of the summer rainfall, especially over the interior plateau, occurs mainly during thunderstorms, and falls of from 2 inches to 4 inches in a day are frequent.

Frost occurs practically over the whole of the interior and is most severe over the central and eastern portions of the Cape, where the duration period extends from 150 to over 200 days. Over the greater portion of the Orange Free State and southern Transvaal the frost period lasts 100 to 150 days. From the central Transvaal northwards the incidence of frost diminishes gradually to a belt of country in the Limpopo Valley, which is frost-free. This condition extends eastwards and southwards over the lowveld of the Transvaal, Zululand, and Natal and to a narrow belt right round the coast of the sub-continent.

The mean annual temperature over the greater part of the Union is extraordinarily uniform, due largely to its plateau structure. The warmest parts in the Union are in the deep valleys of the Orange River and of the Olifants River on the west coast, and of the Tugela, Komati, and other rivers on the east.

The relative humidity of the air of the Union as a whole is highest towards the end of February and the beginning of March, after which it falls rapidly to the middle of September and then starts to rise.

Evaporation all over the Union from free water surfaces is largely in excess of the average annual rainfall and, as far as has been ascertained, varies from twice to five times as much.

The soils of the Union are extremely variable in character and composition. The official soil map of the Union recognizes some nine different soil provinces, but these show little correlation with the climate and vegetation. It is hoped that the present vegetation map may be the means of bringing further light to bear upon this important aspect of the subject.

The natural vegetation of the Union consists of Forest, Parkland, Grassland and Desert Shrub. Forest occupies a very small proportion of the country; in fact, the indigenous timber forests do not cover more than 778,000 acres. They are confined chiefly to the region of constant rainfall in the south and to the seaward slopes and deep kloofs of the southern and eastern escarpments.

The southern and eastern mountain forests are typical of those of temperate evergreen forests, while the coastal forests are more tropical in character.

Parkland vegetation covers the central and north-eastern portion of the country. Thornbush characterizes the central portion, while evergreen and deciduous trees are one of the main features of the north-eastern portion. Grassland covers the eastern portion of the Union. Between the great escarpment and the coast tall grass dominates; on the rolling plains of the high-veld short grass is the feature of the landscape; whilst to the west, in the lower and warmer country known as middle veld, a much more mixed and varied type of grassland occurs.

Desert shrub covers a large portion of the western half of South Africa. Perennial succulents and woody shrubs largely compose this desert vegetation, but annual herbs and grasses may also periodically dominate the vegetation in certain parts.

## FOREST.

Three main types may be distinguished :—Evergreen and deciduous bush and sub-tropical forest, temperate evergreen forests, and evergreen sclerophyllous bush.

### (1) EVERGREEN AND DECIDUOUS BUSH AND SUB-TROPICAL FOREST.

Stretching from East London northwards to beyond our boundary is a narrow belt of dense vegetation which has a more distinctly tropical character than that seen elsewhere in South Africa. The vegetation includes mangrove swamps, palm belts, thorn thickets, streambank bush, and evergreen forests. It is a region of drowned valleys and sandy bush-covered dunes. The altitude varies from sea-level to 800 feet. It is a frostless region, and experiences a summer rainfall of from 30 to 50 inches. The farther north one proceeds the more tropical the vegetation becomes, both in general appearance and in the actual trees, shrubs, and other plants found. Mangroves increase in intensity and importance northwards, while palms and wild bananas characterize the vegetation and make an impenetrable bush. The palms, which are a feature of this area, are the wild date palm *Phoenix reclinata*, the Ilala palm *Hyphaene crinita*, and the endemic Pondoland coconut palm *Jubacopsis caffra*, while in Portuguese territory the coconut palm *Cocos nucifera* is thoroughly at home. Fringing the lagoons and mud swamps are the mangroves *Avicennia officinalis*, *Rhizophora mucronata*, and *Bruguiera gymnorhiza*, and usually associated with them are the tropical shrubs, *Hibiscus tiliaceus* and *Barringtonia racemosa*.

Lianes and climbing plants form a very conspicuous feature of the bush, and in its shade it harbours a dense growth of shade-loving plants. The forests, which bear a distinctly tropical impress, have been very largely exploited. Originally they contained many valuable timbers, such as the "Cape box" *Buxus Macowani*, the "Cape mahogany" *Trichilia emetica*, the "Cape ebony" *Heywoodia lucens*, and the "umzimbeet" *Milletia caffra*, but now many of these forests, especially in Natal and Zululand, have almost entirely disappeared with the cultivation of sugar-cane.

The most characteristic trees and shrubs are the "flat crown" *Albizia fastigiata*, the "red milkwood" *Mimusops caffra*, the "kaffir plum" *Harpephyllum caffrum*, the "umzimbeet" *Milletia caffra*, and the "Natal plum" *Carissa grandiflora*.

### • (2) TEMPERATE EVERGREEN FORESTS.

The true timber forests are found only in the southern, south-eastern, and eastern portions of South Africa, and consist of both coastal and inland forests. They are usually situated on the eastern and south-eastern aspects of the mountain ranges extending from the Cape to the Transvaal, and occur where the rainfall varies from 35 to 70 inches and more. The most extensive forests are found in the neighbourhood of Knysna and George, on the Elandsberg and the Amatola Mountains in the neighbourhood of Kingwilliamstown, in the neighbourhood of Port St. Johns, and in the Woodbush Mountains of the Transvaal. Between these centres there are many isolated patches of forest both along the eastern escarpment and along the coast. Nearly all these forests have suffered very severely from the hand of man, and had it not been for State protection little of these indigenous forests would be remaining to-day. Many have already been entirely destroyed in the southern portion of the Cape and in the Cape Peninsula, while along the coast belt in Natal nearly all have long given way to the sugar industry.



The chief components of the forests are the coniferous "yellowwoods" *Podocarpus* spp. which frequently attain a height of 100 to 150 feet. They yield valuable timber which is used for structural and other purposes. Associated with the "yellowwoods" are a great variety of broad-leaved evergreen trees. These increase in number of species the farther north the forests extend, and at the same time become more tropical in character.

The most important timber trees after the "yellowwoods" are the "black ironwood" *Olea laurifolia*, the "Cape beech" *Myrsine (Rapanea) melanophloeos*, the "assegai bos" *Curtisia faginea*, the "stinkwood" *Ocotea bullata*, the "sneezewood" *Ptaeroxylon obliquum*, the "white ironwood" *Toddalea lanceolata*, and the "kamassi" *Gonioma kamassi*.

In the south-western part of the Cape occur the "cedar" forests of South Africa composed of *Widdringtonia juniperoides*. They can hardly be termed true forests, as the trees seldom form a close canopy, but occur mainly in isolated formation on the slopes of the Cedarberg Mountains. These trees yield a light, soft, durable timber, which is regarded as one of the most valuable in the country.

### (3) EVERGREEN SCLEROPHYLLOUS BUSH.

This covers an angular strip of country stretching roughly from the Olifants River on the west coast to Port Elizabeth on the south. On the north it is bounded by the Cape mountain ranges. The country on the whole is mountainous and includes many wide open valleys. The vegetation is composed mainly of bush or scrub, in which small hard leathery leaves are the predominating feature. It is commonly known as *sclerophyllous* vegetation. The general aspect of the vegetation has a remarkable uniformity and is of a characteristic dull grey-green colour. The region is essentially one with a winter rainfall and a hot dry summer. The absence of grassland in the general landscape is a conspicuous feature, although there is dispersed throughout the bush and scrub a large number of different species of grasses. The rainfall averages about 29 inches, but in several of the mountainous parts it far exceeds this and may even reach 100 inches and over.

The seashore with its sand dunes, the sandy flats, the inland valleys and plains, vleis and mountain slopes, all bear their own characteristic vegetation. On the mountain slopes "sugar bush" *Protea* spp. and "silver tree" *Leucadendron argenteum* are found. Characteristic plants of the vleis are the "palmet" *Prionium serratum* and the "varkblom" *Zantedeschia ethiopica*. The inland valleys and plains are usually densely covered with low bush or scrub, consisting of the "harpuisbos" *Euryops tenuissimus*, the "kapokbos" *Eriocephalus umbellulatus*, the "doringbos" *Metalasia muricata*, and many others. Where man has upset the balance of nature in the valleys and on the mountain slopes the "rhenosterbos" *Elytropappus rhinocerotis* usually dominates. On the sand dunes common shrubs and bushes are the "waxberry" *Myrica cordifolia*, the "dronkbos" *Passerina ericoides*, the "kraaibos" *Rhus crenata*, and the "duinbos" *Mundia spinosa*, while along the coast one of the most characteristic bushes is the "wit melkhout" *Sideroxylon inerme*.

Throughout the region the dominating families are the *Proteaceae*, *Ericaceae*, *Restionaceae*, and *Compositae*. The region is also remarkable for the large number of endemic plants which it contains. The vegetation of this region has little in common with the rest of South Africa, and there is much evidence to suggest that even the origin of this flora may be different from that of the rest of South Africa. It is the richest floral region in Africa, in fact it is one of the richest floral regions of the world, and it has long been renowned for its wealth of bulbous plants, which have for some time past been introduced into cultivation throughout Europe and many other parts of the world.

## PARKLAND.

Parkland vegetation covers the north-eastern and central portions of the sub-continent. Three well-marked types occur:—Open woodland and orchard country of evergreen and deciduous tree and bush, open woodland country of sub-tropical evergreen and deciduous tree and thorn forest, and thorn country.

### (1) EVERGREEN AND DECIDUOUS TREE AND BUSH.

Open woodland and orchard country characterizes the mountainous and rugged country in the western and eastern Transvaal, where the country is described locally as "Banken veld". The rainfall over this area varies from 25–35 inches, and the underlying rocks are composed largely of quartzites.

The common trees composing this open woodland and orchard country vegetation are:—The "Beukenhout" *Faurea saligna*, the "wilde sering" *Burkea africana*, "suikerbos" *Protea abyssinica*, the "kaffir-wag-'n-bietje" *Acacia caffra*, the "blinkblaar wag-'n-bietje" *Zizyphus mucronata*, the "vaalboom" *Terminalia sericea*, the "huilbos" *Peltophorum africanum*, the "rooibos" *Combretum Zeyheri*, *C. Gueinzii*, the "drolpeer" *Dombeya rotundifolia*, the "red ivory" *Rhamnus Zeyheri*, the "moepel" *Mimusops Zeyheri*, the "suurpruim" *Ximenia caffra*, the "respies" *Heceria paniculata*, the "bergpruim" *Pappia fulva*, the "dikbas" *Lannea discolor*, and the "kareeboom" *Rhus lancea* and *R. Gueinzii*.

In the eastern portion, where the country falls within the rain shadow of the Drakensberg, tall arborescent Euphorbias, *E. ingens* and *E. Cooperi* and arborescent Aloes, *A. castanea*, *A. Marlothii* form a conspicuous feature in the landscape.

Similar open woodland and orchard country covers the mountainous country to the north known as the Limpopo Highlands, especially on the Waterberg plateau, where the sandstones and quartzites give rise to similar soils. On the Pietersburg plateau the vegetation is mainly orchard country in which deciduous trees dominate. The trees are chiefly *Acacia* spp., "maroola" *Sclerocarya caffra* and the "naboom" *Euphorbia ingens*.

The vegetation on the eastern slopes of the northern Drakensberg is typical of that of "open woodland" country. It consists of tall grass (4 to 6 feet) interspersed with bush and tall trees. The characteristic trees of this region, which receives a rainfall of 35 to 45 inches, are the "mobola plum" *Parinarium mobola*, the "kajatenhout" *Pterocarpus angolensis*, the "waterboom" *Syzygium cordatum* and the "hill matome" *Diospyros mespiliformis*.

On the Zoutpansberg range a remarkable assemblage of temperate and tropical species and of hygrophyllous and sclerophyllous plants is found within comparatively short range. Temperate broad-leaved evergreen forests, tropical evergreen forests, and thorn forest all occur in succeeding ranges from south to north, and with decreasing rainfall.

The tropical element is represented by such trees as *Adansonia*, *Androstachys*, *Gyrocarpus*, *Entandrophragma*, *Pseudocadia*, *Wrightia*, etc., while the thorn forest is characterized by trees belonging to the genera *Commiphora* and *Sesamothamnus*.

## (2) SUB-TROPICAL EVERGREEN AND DECIDUOUS TREE AND THORN FOREST.

This type of vegetation covers the low-lying country ranging from 500 to 2,500 feet in Zululand, Swaziland, and the eastern and northern Transvaal.

The vegetation is mainly dry thorn forest with occasional large evergreen trees scattered through it. Over the northern portion the rainfall rarely exceeds 15 inches, and frequently it is much less. Over the eastern portion it varies from 15 to 30 inches, but a long dry period is nearly always experienced. South of the Olifants River the vegetation is typically an *Acacia* thorn forest. Tall trees are the dominating feature, and of these *Acacia pallens* is the most characteristic, especially on the drier soils. On soils which are inclined to be waterlogged dense thickets of *Acacia rostrata*, *A. arabica* var. *kraussiana* and *A. litakunensis*, commonly occur. Along the water-courses and at the edges of swamps the "fever tree" *Acacia xanthophloea* is typical of this region.

Evergreen trees typical of the southern portion of this region, especially of the riverine vegetation, are *Albizia versicolor*, *Diospyros mespiliformis*, *Euclea divinorum*, *Ficus sycamorus*, *Lonchocarpus capassa*, *Adina Galpinii*, *Rauwolfia natalensis* and *Syzygium cordatum*. Deciduous trees commonly associated with the thorn forest throughout the region are the "maroola" *Sclerocarya caffra*, the "South African mahogany" *Azelia quanzensis*, the "van wykshout" *Bolusanthus speciosus*, the "sausage tree" *Kigelia pinnata* and *Balanites Maughamii*. Along the water-courses throughout the region the palms *Phoenix reclinata* and *Hyphaene crinita* are also common.

North of the Olifants River on the drier situations the "mopane" *Copaifera mopane* and several species of *Commiphora* often become dominant, and these are commonly associated with the "baobab" *Adansonia digitata*, *Acacia Senegal*, *Terminalia pruinoides*, *Kirkia pubescens* and *Sterculia* sp.

Characteristic trees along the water-courses in the northern and north-western portions are *Acacia albidia* and *Pseudocadia zambesiaca*. In the southern portion of this region the dominant grasses belong to the genera *Themeda*, *Panicum*, *Urochloa*, *Digitaria*, *Hyparrhenia* and *Cymbopogon*; in the northern portion *Aristida*, *Enneapogon*, *Schmidtia*, and *Antheophora* become dominant.

## THORN COUNTRY.

The type of vegetation known as "thorn country" covers practically the whole of the central portion of South Africa as far south as latitude 28°. It covers the greater part of British Bechuanaland, the Bechuanaland Protectorate, the north-western and central Transvaal, and the eastern portion of South-West Africa.

Over the eastern portion the rainfall varies from 20 to 25 inches, over the central portion it ranges from 15 to 25 inches, while the western portion receives from 5 to 15 inches.

Deep sandy soils characterize the region as a whole. Thorn bush and thorn trees are the dominating features of the landscape. The most characteristic tree of the whole region is the "camelthorn" *Acacia giraffae*. It is common throughout the area, except in the low-lying south-eastern portions where the soils are highly alkaline, and here the "vaalkamcel" *Acacia haematoxylon* assumes dominance. There is a great variety of *Acacias* throughout this area. The commonest are *A. karroo*, *A. detinens*, *A. dulcis*, *A. hebeclada*, *A. maras*, *A. stolonifera*, *A. Burkei*, *A. pallens*, *A. permixta*, *A. robusta*, *A. Gerrardii*, *A.*

*Gillettiæ*, *A. rehmanniana*, and *A. litakunensis*. Other typical trees and bushes are *Boscia albitrunca*, *Olea verrucosa*, *Tarchonanthus camphoratus*, *Burkea africana*, *Terminalia sericea* and *Terminalia pruinoides*.

In the western portion large tracts of country are covered by the "driedoring" *Rhigozum trichotomum* which is frequently associated with *Parkinsonia africana* and *Catophractes Alexandri*. In the south-western portion the sand has been blown into long, wide, undulating dunes, which usually have a west-north-west trend. These are mainly grass covered with scattered thorn bush. The dominant grasses are the "tall" and the "short bushman grass", *Aristida ciliata* and *A. uniplumis* respectively. On the tops of the dunes the most characteristic grass is the coarse *Danthonia suffrutescens*.

In the country usually referred to as the Kalahari desert, one of the most characteristic herbaceous plants is the "tsama" *Citrullus vulgaris* var. On this most of the animal life in this semi-desert region depends for its water supply.

The north-eastern extension of the thorn country comprises the bushveld of the Transvaal. It is covered by bush and tree and a more or less luxuriant grass cover. The dominant trees and bush belong mostly to the genus *Acacia* and *Dichrostachys*, and some magnificent timber trees still exist in the eastern portion, where they are known locally as "apiesdoring" *Acacia Burkei* and *A. Galpinii*.

A great variety of grasses occurs in this bushveld country, and their distribution is closely associated with the different soil types which occur here. The dominant grasses belong to the genera *Themeda*, *Hyparrhenia*, *Panicum*, *Urochloa*, *Digitaria*, *Brachiaria*, *Setaria*, *Pennisetum* and *Chloris*.

## GRASSLAND.

Grassland vegetation occupies the eastern portion of South Africa. It is a region of spring and summer rainfall and long, cold, dry winters. The rainfall over the area varies from 20 to 40 inches. Three distinct types of grassland can be distinguished :—Tall grass country which lies east of the great Drakensberg escarpment and stretches almost to the coast, and which receives a rainfall of 30 to 40 inches ; short grass country which occupies the high-lying portion of the great inland plateau, receives a rainfall of 25 to 30 inches, has a very short growing period and is subject to intense cold in winter ; mixed grass country which lies west of the short grass plains, covers a greater variety of soils, receives a lower rainfall than the short-grass country, and is not subjected to such intense cold.

## (1) TALL GRASS.

This covers the country which lies between the eastern escarpment and the coastal belt. The dominant grass throughout is *Hyparrhenia hirta* and allied species. It forms a dense cover and a uniform sward. In moister situations taller grasses belonging to the genus *Cymbopogon* are dominant. *Cymbopogon* and *Hyparrhenia* characterize the vegetation on the higher slopes of the escarpment. Evergreen forest occurs wherever there is permanent water in the soil, while scattered bushes of *Protea* and *Leucosidea* are common. Where the rainfall is above 40 inches the grass cover becomes more mixed in composition, and grasses belonging to the genera *Andropogon*, *Tristachya*, *Trichopteryx*, *Harpechloa*, and *Miscanthidium* assume dominance.

In the low-lying, sheltered, and drier valleys at lower altitudes, *Acacia* trees, thorn bush, and arborescent succulents such as *Aloes* and *Euphorbias* invade the grass and hold their own. In such localities the dominant grasses belong to the genera *Themeda*, *Digitaria*, *Panicum*, *Rhynchelytrum*, *Setaria*, *Pennisetum* and *Chloris*.

## (2) SHORT GRASS.

Short grass covers the high-lying country (5,000 to 6,000 feet) west of the Drakensberg escarpment. This country is known locally as the Highveld. It is essentially grass country devoid of natural tree and bush. The dominant grass throughout the region is a short or dwarf form of *Themeda triandra*. Large tracts of country are frequently covered with the grass almost to the exclusion of all others. Other grasses frequently associated with *Themeda triandra*, especially on poor soils, are *Elionurus argenteus*, *Digitaria tricholaenoides*, *Monocymbium cerisiforme*, *Pennisetum Thunbergii*, *Setaria flabellata*, *Panicum natalense*, *Arundinella Ecklonii*, *Andropogon shirensis*, *Andropogon appendiculatus* and *Harpechloa capensis*. Associated with the grass cover and intermixed with it is a large number of herbaceous plants.

## (3) MIXED GRASS.

This covers a wide tract of country lying between the Highveld on the east and the thorn country of the Kalahari on the west. The region includes a number of different geological formations and consequently exhibits a great range of soils. These in turn show considerable variation in the grass covering. The region as a whole is pure grassland, but frequently on rocky outcrops bush and scattered trees may occur.

The dominant grasses belong to the genera *Themeda*, *Cymbopogon*, *Hyparrhenia*, *Tristachya*, *Triopterix*, *Digitaria*, *Antheophora*, *Aristida*, *Eragrostis*, *Elionurus*, *Urelytrum* and *Trachypogon*.

## DESERT SHRUB.

## (1) THORN COUNTRY AND DESERT SHRUB.

Occupying the high country between the Kalahari on the west and the Dry Harts-Vaal Valley on the east, is a mixture of thorn scrub and desert shrub not met with elsewhere in the Union. The thorn scrub is composed largely of *Acacia litakunensis*, *Rhus tridactyla*, *Olea verrucosa*, *Tarchonanthus camphoratus*, *Lebeckia macracantha*, *Grewia flava*, *Zizyphus mucronata* and *Nymania capensis*. The desert shrubs associated with the thorn scrub are chiefly *Rhigozum trichotomum*, *R. Obovatum*, *Pentzia incana*, *Chrysocoma tenuifolia*, *Euryops multifidus*, and *Eriocephalus pubescens*.

## (2) DESERT SHRUB.

The Desert shrub vegetation covers a broad belt of country extending from South-West Africa southwards to the Province of the Cape of Good Hope, when it broadens out considerably and extends almost to the coast at Port Elizabeth and Port Alfred, where it creeps down the valleys of the Sundays and the Great Fish Rivers. The rainfall over the whole area varies from 5 to 15 inches. It is greatest in the south-eastern portion. The southern portion of this area is composed of Karroo beds with rich and shallow soils, while in the central and northern portions granites and gneiss occur. Although there are many distinct plant associations, there is a remarkable uniformity in the general appearance of the vegetation throughout the area. Except in the extreme south, where succulents dominate, desert shrubs and shrublets characterize the whole area. The plants may be either woody or fleshy, and they are always widely spaced in bare soil. They are generally of a fairly uniform height. The leaves in most cases are small and well adapted to withstand desert conditions. Except in the southern portion trees are not a conspicuous feature within the area. Common trees, however, are the "sweet-thorn" *Acacia karroo*, the "bergpruim" *Pappea capensis*, the "guarri" *Euclea undulata*, and the "witgatboom" *Boschia albitrunca*.

The most characteristic bushes and shrubs throughout the area are the "driedoring" *Rhigozum trichotomum*, the "brosdoring" *Phaeoptilum spinosum*, the "kriedoring" *Lycium arenicolum*, the "klapperbos" *Nymania capensis*, and the "kruidjic-roer-my-nie" *Melanthus comosus*, while the typical shrublets are the "Karoo bushes" *Pentzia virgata*, *P. incana*, *P. globosa*, and *Chrysocoma tenuifolia*, the "harpuisbos" *Euryops multifidus* and "ganna" *Salsola aphylla* and *S. Zeyheri*. Common succulents throughout are the "kraalbos" *Galenia africana*, the "geel melkbos" *Euphorbia mauritanica*, the "boterboom" *Cotyledon fascicularis*, and the "doringvyebos" *Mesembrianthemum spinosum*.

The Karroo proper, which occupies the southern portion of this area and is really a great shallow basin lying at an altitude of 2,000 to 3,000 feet, is covered with fleshy succulents widely spaced in the bare soil and harbours many bulbous and tuberous plants. In the southern portion tree growth is sometimes a conspicuous feature. The trees are mainly the guarri *Euclea undulata*, the "bosyerhout" *Dodonia Thunbergiana*, the "boerboom" *Scholia speciosa*, and the "bergpruim" *Pappea capensis*. In the south-eastern portion, where the rainfall is heavier, tall arborescent Euphorbias and Aloes form a conspicuous feature in the landscape, and with them are associated many bushy succulent Cotyledons and Crassulas. In the western part of the Karroo the "kraalbos" *Galenia africana* and the "geel melkbos" *Euphorbia mauritanica* are conspicuous.

North of the Karroo on the country lying above 4,000 feet, the vegetation is composed almost entirely of "karroo bush" or woody shrubs. These occur mainly on shallow and rocky soils. Wherever the soil is sandy and deeper the "driedoring" *Rhigozum trichotomum*, a bush which usually attains a height of 3 to 4 feet, mostly dominates. After rain this bush is densely covered with white flowers and forms a conspicuous feature of the Karroo. On the rocky kopjes in this area another species of "driedoring," otherwise known as the "wilde granaat" *Rhigozum obovatum*, is a remarkable sight after rain, with its masses of bright yellow flowers.

The central portion of this area, which includes Bushmanland and Namaqualand is composed of vast plateaux and plains. The granitic soils are mostly sandy and are mainly covered by the "driedoring" *Rhigozum trichotomum*, the "baviaanskos" *Augea capensis*, and, where the drainage is poor, by "ganna" *Salsola* spp. On the deep sandy plains the "bushman grass" *Aristida brevifolia* often dominates, and with it is frequently associated the "lemoendoring" *Parkinsonia africana*. Along the dry rivers in this area the "camelthorn" *Acacia giraffae* is characteristic, while on the hills the "kokerboom" *Aloe dichotoma* is common. With it are frequently associated the "gifboom" *Euphorbia virosa* and the "melkboom" *Euphorbia dregeana*.

North of the Orange River in South-West Africa desert shrubs are again characteristic. The low-lying valleys are generally occupied by the "aggenyns-melkbos" *Euphorbia gregaria*, while *Rhigozum trichotomum* and the tropical Bignoniaceous shrub, *Catophractes Alexandri*, occur on the sandy soils. On the shallow soils the "small bushman grass" *Aristida obtusa* dominates, while on the deeper soils the "tall Bushman grass" *Aristida ciliata* and the "twaa grass" *Aristida brevifolia* are the prevalent grasses.

### (3) DESERT SUCCULENTS AND DESERT GRASS.

True desert occurs along the west coast of South Africa from just beyond the Olifants River in the south to beyond our boundary in the north. The belt varies in width from 10 to 80 miles. Its broadest portion is from Luderitz Bay to Conception Bay. It extends inland down the valley of the Orange River nearly as far as Upington, and broadens out over a large part of Great Namaqualand, with a corresponding extension north of the Orange River. The average rainfall throughout this area is from under 1 up to 5 inches. Over many parts of the country rain frequently does not fall for several years. The whole country throughout the year has a typical desert appearance. The few plants that do occur are mainly stem succulents, and there are always wide spaces of bare ground between them.

The coastal desert extends from the western slopes of the escarpment to the coast line and five distinct zones can usually be distinguished, viz., the western slopes of the escarpment, the gravel plains, the sand dunes, the rocky hills, and the seashore.

The plants that characterize the western slopes are the "kokerboom" *Aloe dichotoma*, the "gifboom" *Euphorbia virosa*, the "melkboom" *Euphorbia Dregeana*, and the "Bushman's candle" *Sarcocaulon Burmanii*.

The gravel plains may be destitute of obvious plants for miles and miles. Sometimes they bear a scanty growth of the "vogelstruisgras" *Eragrostis spinosa* and the "twaa grass" *Aristida brevifolia*, and occasionally the "baviaanskos" *Augea capensis* and several species of the "Bushman's candle" *Sarco-*

*caulon* spp. In the north in the neighbourhood of Walvis Bay the extraordinarily interesting and remarkable coniferous plant, the "tumboa" *Welwitschia Bainesii*, occurs. With it is commonly associated one of the "schilpadbossies" *Zygophyllum Stapfi*.

There is little vegetation on the sand dunes, but occasionally the "steekriet" *Eragrostis cyperoides* and the "vogelstruisgras" *Eragrostis spinosa*, in widely isolated tufts, are found.

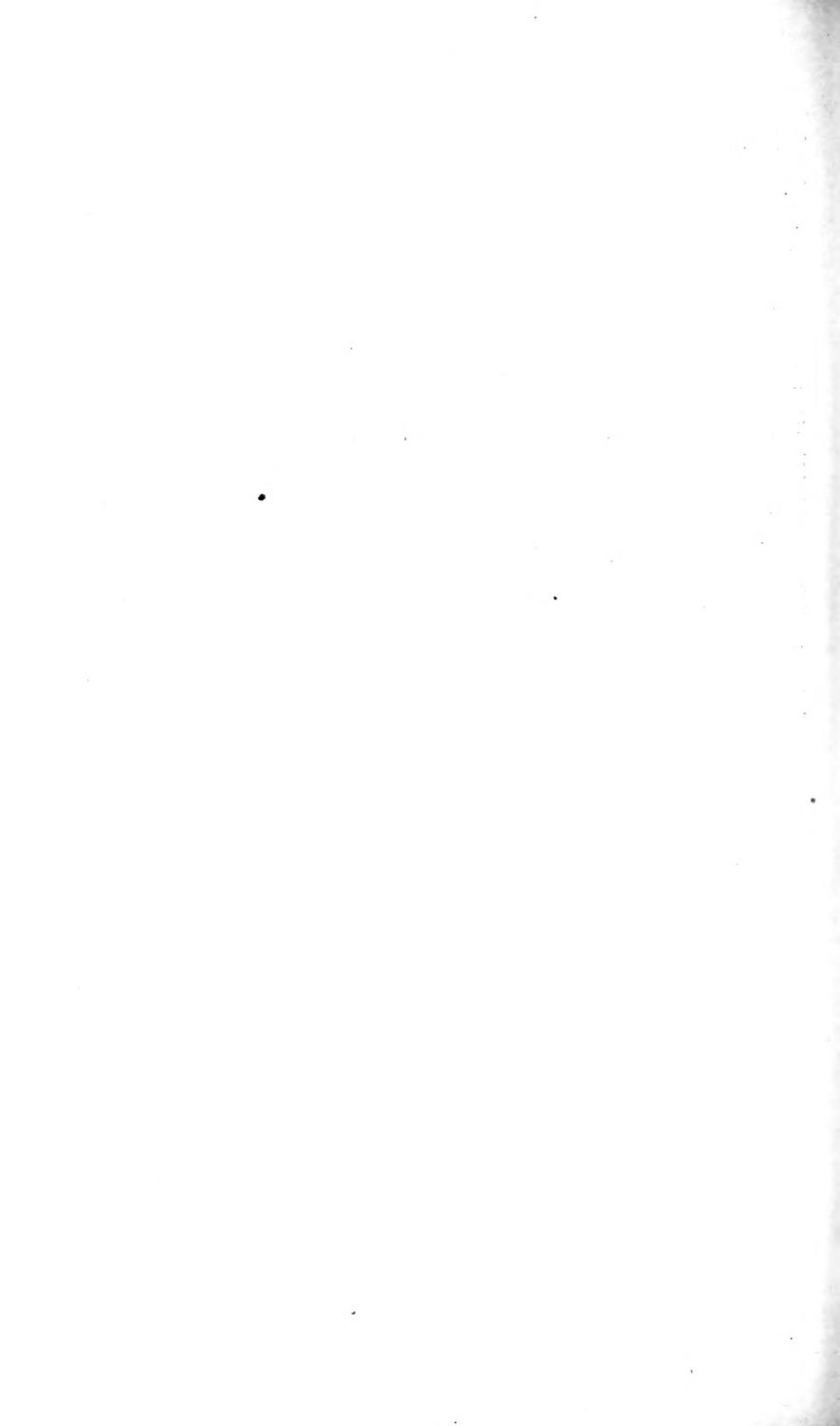
Along the seashore a few interesting succulents belonging to the genus *Salicornia* and *Salsola* have established themselves.

Along the river valleys in this desert belt several trees such as the "camelthorn" *Acacia giraffae*, the "anaboom" *Acacia albida*, the "ebbehout" *Euclea pseudebenus*, the "tamarisk" *Tamarix articulata* and the "hardekool" *Combretum primigenum* find sufficient moisture to establish themselves and make slow growth. The low lying valleys are frequently covered with large spreading bushes of the "aggennys melkbos" *Euphorbia gregaria*. Where the river mouths become buried in the sand dunes is found one of the most typical plants of this belt, the remarkable "narras" *Acanthosicyos horrida*, a leafless cucurbitaceous plant which affords valuable food to the hungry Natives of this area.

The vegetation found in the valley of the Orange River is equally remarkable and interesting. The rocky mountains which flank this river harbour an apocynaceous plant, the "halfmens" or "elephant's trunk" *Pachypodium namaquanum*, a tall cylindrical stem succulent which attains a height of 12 to 15 feet and bears at its crown a few small leaves and flowers. It has the remarkable habit of always pointing northwards. Other interesting stem succulents in these hills are the Namaqualand "spckboom" *Ceraria namaquensis*, the "kokerboom" *Aloe dichotoma*, the "gifboom" *Euphorbia virosa*, and several species of *Cotyledon*, *Sarcocaulon*, and *Commiphora*.

In the deep sandy valleys a few trees and shrubs occur. These are mainly the "camelthorn" *Acacia Giraffae*, the "witgatboom" *Boschia albitrunca*, the "swartstorm" *Cadaba juncea*, the "ebbehout" *Euclea pseudebenus*, the "bergpruim" *Pappea capensis*, and *Sisymbrium sparteum*.





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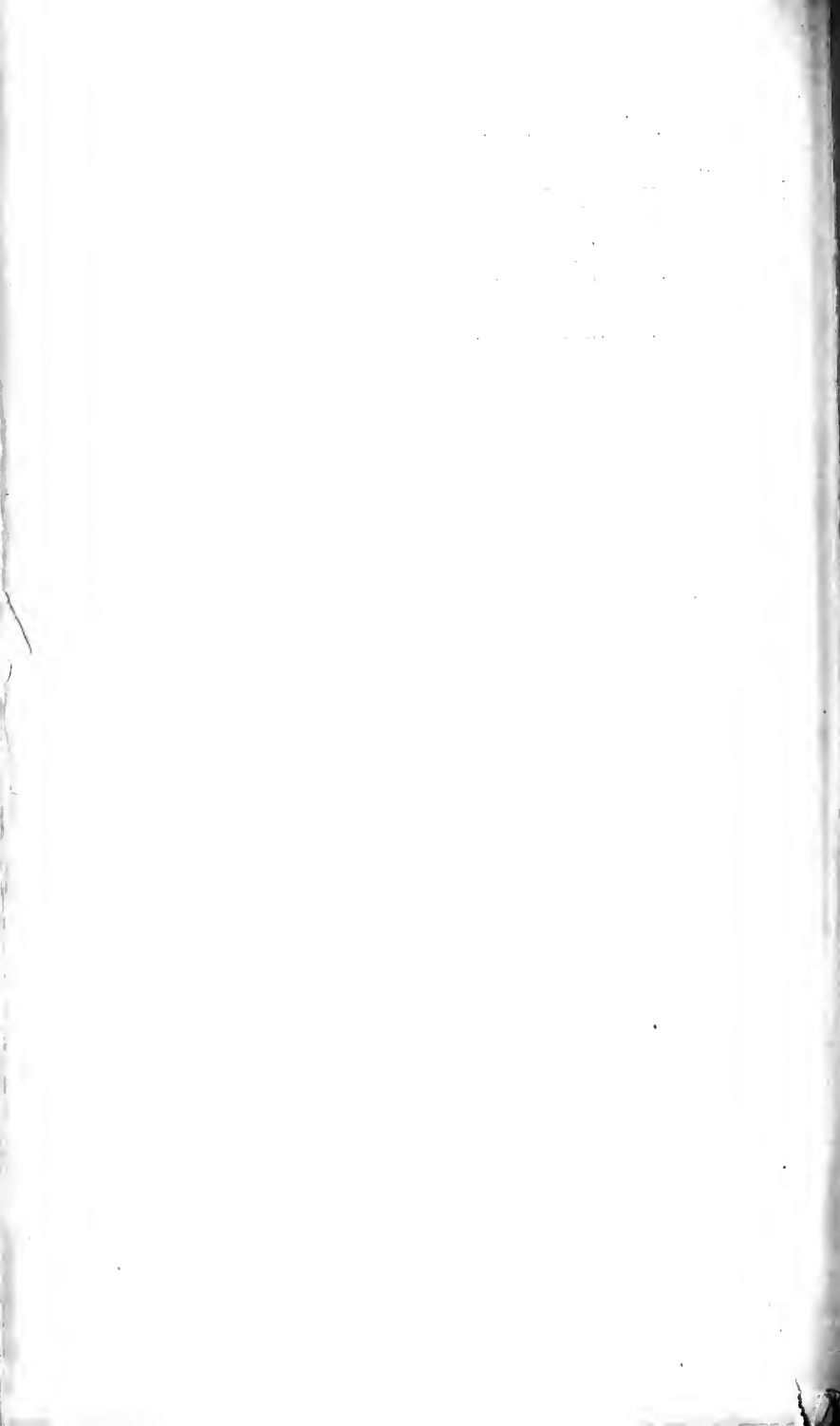
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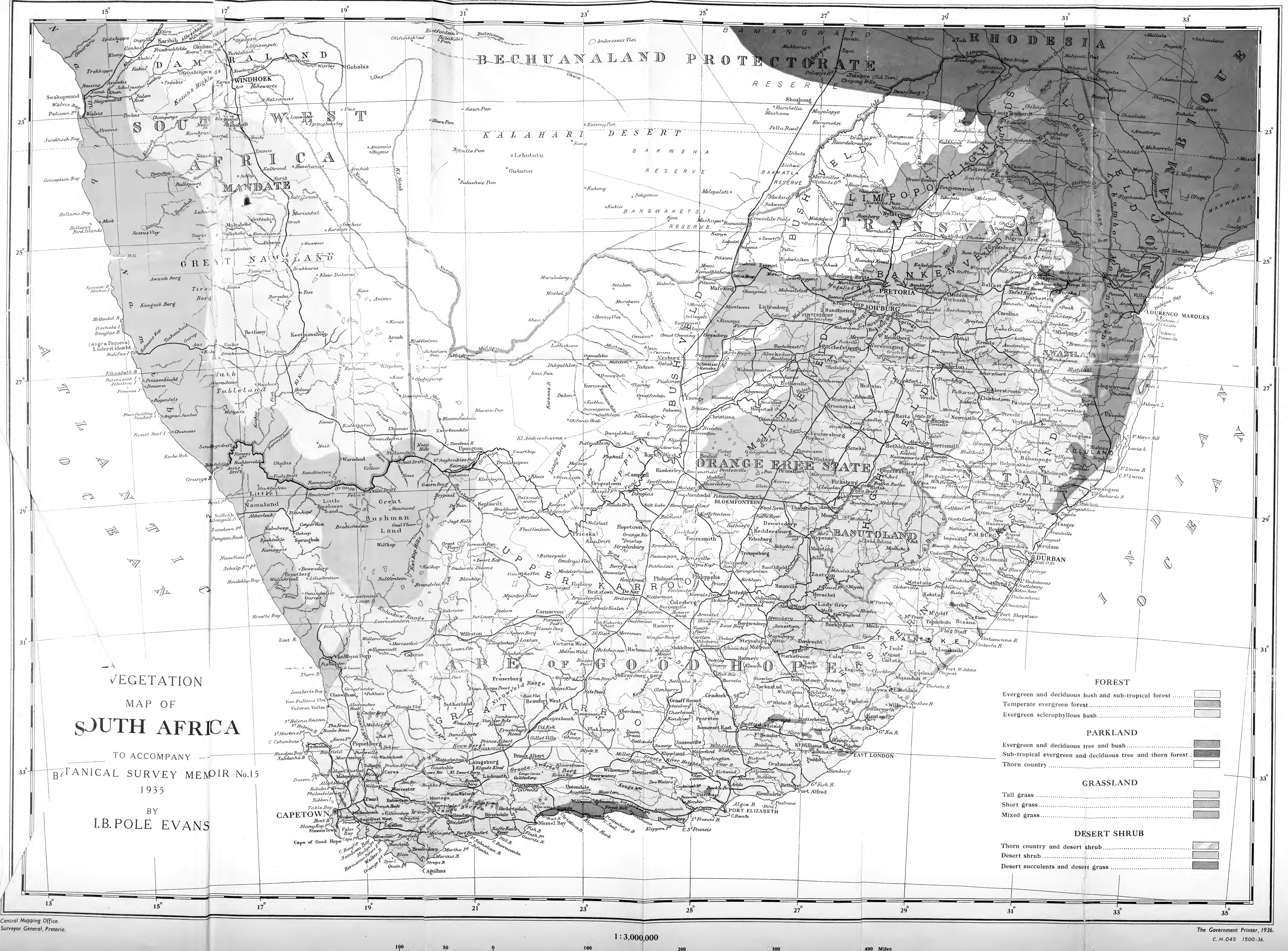
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UNION OF SOUTH AFRICA.

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DEPARTMENT OF AGRICULTURE AND FORESTRY

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BOTANICAL SURVEY MEMOIR No. 16

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# The Seed-drift of South Africa

AND SOME

## Influences of Ocean Currents on the Strand Vegetation

BY

JOHN MUIR, M.D., D.Sc. (EDIN.), D.Sc. (STELL.)

“ Perhaps of all seas, the Indian Ocean sends the strangest things to her beaches in the form of flotsam for the sun to exhibit, the wind to turn over and the mind of man to contemplate.”  
(*Mandarin Gardens*, Stacpoole, H. de V., 1933.)

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Division of Plant Industry,

P.O. Box 994,

Pretoria,

22nd July, 1937.

THE SECRETARY OF AGRICULTURE AND FORESTRY.

Sir,

I have the honour to submit for publication as Botanical Survey Memoir No. 16 an article by Dr. J. Muir on " Drift Seeds ".

Dr. Muir has devoted many years of study to the subject of drift seeds found on the coast of Southern Africa and the results of his researches will long remain a classic as far as South Africa is concerned.

The subject is not purely academic but has a practical bearing on the course of ocean currents. The Carnegie Corporation awarded Dr. Muir a Carnegie Travelling Grant, which he utilised by going overseas to study collections of ocean-borne fruits and seeds there.

I have the honour to be,

Sir,

Your obedient servant,

I. B. POLE EVANS,

Director, Botanical Survey.





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## INTRODUCTION.

IN regard to the matters discussed in the following pages, the writer possesses first-hand knowledge gleaned in the course of visits made to a number of stations on the South African coast between Walvis Bay and Lourenço Marques, as well as to others in Sierra Leone, the Ivory and Gold Coasts, the French Mandated Territory of the Cameroons, French Equatorial Africa, and Angola, and from a month spent on the coast of Java.

He is indebted to Professor J. F. V. Phillips of Johannesburg for reading the paper and making valuable suggestions.

He desires to tender cordial thanks to the following scientists and scientific departments for supplies of fresh material for comparison with alien seeds and fruits washed up on our shores, and for other assistance:—Dr. I. B. Pole-Evans, Director of the Department of Plant Industry, Pretoria, who is a near relative of a famous pioneer in this subject—the late Sir Daniel Morris—and by his interest therein follows a family tradition; the staff of that Department, especially Dr. E. P. Phillips, Miss H. Forbes, Mr. A. P. D. McClean, and Dr. H. G. Schweickerdt; Professor R. H. Compton, Director of the National Botanic Gardens, Kirstenbosch; Professor G. Nel and Professor P. A. van der Byl, Stellenbosch; Professor C. E. B. Bremekamp; Sir A. W. Hill, Director of the Royal Botanic Gardens, Kew, and his staff, especially Dr. F. N. Howes and Dr. John Hutchinson; Dr. Irvine, Achimota College, Accra, and staff; Dr. W. M. D. van Leeuwen and Dr. D. van Slooten, Buitenzorg, Java; Professor A. F. Fischer, Director of Forestry, Manila; Dr. C. J. Stauffacher, Inhambane; the Directors of Agriculture for Queensland, Fiji Islands, Hawaiian Islands (with Dr. G. P. Wilder), Mauritius, British Guiana, Trinidad, and Ceylon; the Director of the Botanic Gardens, Sibpur, Calcutta; Professor H. Humbert, Director of the Museum National d'Histoire Naturelle Botanique, Paris; Inspector A. Ledreux, Tamatave; and others mentioned hereafter in the text.

He also desires to thank Dr. L. Gill, Director of the South African Museum, Capetown, where most of the work which it was possible to do in South Africa was performed; as well as Miss G. Garabedian and Dr. K. H. Barnard on the staff of the same institution; also Professor J. W. Bews, Maritzburg, for much wise counsel and encouragement; Miss H. J. Muir, Wykeham School, Maritzburg; Dr. A. W. Rogers, Director of the Geological Survey, Pretoria; and Miss M. A. Knowles and Dr. R. Lloyd-Praeger, Dublin.

A valuable collection of fresh material has thus been assembled. It supplements the very large accumulation of alien and local seeds found by the writer in the South African Drift, which had to be made before the investigation could be commenced. Previously the number of South African drift-seeds in museums was extremely scanty.

Finally he thanks the Research Grant Board (Carnegie Corporation of New York) most sincerely for a substantial grant in aid of the work.

JOHN MUIR.

“ Leeuwarden ”,  
Riversdale,  
South Africa, July 1936.



# The Seed-drift of South Africa and some Influences of Ocean Currents on Strand Vegetation.

BY

JOHN MUIR, M.D., D.Sc.(EDIN.), D.Sc.(STELL.)

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## SECTION I.

---

### CHAPTER I.

#### THE SOUTH AFRICAN SEED DRIFT OF ALIEN ORIGIN.

The study of the South African alien seed-drift has hitherto aroused little interest. At an early stage in my investigations I was shown four such seeds by a South African botanist now deceased, who told me they were all the kinds I would ever find. Two of these were *Entada gigas* and *Caesalpinia crista*, the third he named *Mucuna pruriens*, and the fourth was unknown to him. The third seed was really *Mucuna urens* DC. (*M. Sloanei* Fawc. and Rendle) and not a South African drift specimen, while the fourth belonged to *Intsia bijuga*.

The real difficulties were connected with identification, the lack of any South African collection, the want of a herbarium of tropical plants, and the absence of much of the necessary literature.

After I had amassed a collection of some thousands of drift-seeds an opportunity was presented of visiting the herbarium and museums of the Royal Botanic Gardens at Kew, and inspecting the beach-drift and vast carpological material there. Previous to this, however, I had, through the kindness of Dr. L. Gill, made considerable progress at the South African Museum, although a residuum of undetermined seeds was still left. In the end over 99 per cent. of all seeds were named.

It was found that the seed-drift of South Africa differs from that of the eastern Indian Ocean littoral owing to the inclusion of certain seeds from Madagascar, in some cases unrecorded and not in the herbaria of Kew or Paris.

Some light was thrown on difficult points by collections which I made personally on the beaches of the Ivory Coast, Gold Coast, and more especially of the French Mandated Territory of the Cameroons, and of French Equatorial Africa around Pointe Noire.

The study of the alien seed-drift of any country is fundamentally important not only to the biologist, botanist, and phytogeographer, but also to the oceanographer; and the investigation of the drift of local origin is likewise of considerable interest.

A littoral vegetation is as a rule made up of plants brought by the agency of ocean currents and others derived from the inland region by the agency of rivers, wind, or animals. This applies with special force to the vegetation of the beaches, the mangrove forming another category and being the older of the two.

The proportions of current-borne and inland plants, or plants of inland origin, vary, the latter predominating in temperate regions, to which much of the South African coast may be referred, while the current-borne plants exist in greater numbers in the tropics, including East Africa.

The significance of the study of alien and local oceanic seed-dispersal is connected not only with the origin of the beach vegetation. Looming in the far background are such problems as the relationships of this with the inland vegetation, and the possibility of the derivation of inland plants from littoral plants. These latter questions are, however, beyond the scope of this paper.

### *History and Literature.*

The earliest South African notice of a possible drift-seed known to me is by Peter Kolbe (*Beschr. v. d. K. de G. H.*, I, 256. 1727), who resided in South Africa from 1705 to 1713. It occurs only and vaguely in a description of a reputed cure for snake-bite, and it is by no means clear. He states that the snake-stones are made artificially by the Brahmians, but definitely compares them in form to a "sea-bean". Possibly *Entata gigas* is meant, a seed which is first mentioned in the literature of the European drift seeds in 1570. "Deze slang-stenen," he says, "hebben de gedaante van een Linze, of om beter te zeggen, van een zee-boon." Lady Anne Barnard in May, 1798, was given some "sea-beans" which were found near the mouth of the Breede River in the Swellendam Division and wrote:—"They are highly esteemed by the Dutch, I know not why; they mount and hang them to their watches: I think they would make curious earrings." She stated that she sent two grey sea-beans to Lady Susan Melville to be used for that purpose. Here the seeds were those of *Caesalpinia crista*. She made reference also to seeds of *Coix lachryma—Jobii*. (*S. Africa a Century Ago*, 1901.)

Ibn Batuta visited the Maldives in 1344 and reported the stranding of fruits of *Lodoicea maldivica* (*L. Sechellarum*), which is not, however, a genuinely maritime tree and is not so widely distributed even in the Seychelles.

G. E. Rumphius, who went to Amboina in 1652 in the service of the Dutch East India Company, mentioned the air roots of *Sonneratia* and described both species of *Xylocarpus* and other plants of the Indian Ocean littoral now known to be sea-dispersed.

Other early references to littoral plants and seeds not quoted by Professor A. F. W. Schimper or Dr. H. B. Guppy deserve attention. F. Leguat who was in Rodriguez from 1691-93 stated that coco-nuts washed up there germinate; and J. H. B. St. Pierre, in a letter from Mauritius dated 10 July, 1769, that they are "calculated to float upon the sea, and to sow themselves afterwards in the sands." Later the latter writer referred to the fruits of *Lodoicea*, to a plant which is undoubtedly *Caesalpinia crista*, and to a third which can

only be *Ipomoea Pes-caprae*. He showed considerable insight by asserting that the "seeds" of the mangroves may have been brought by the sea.

William Burchell who sojourned in St. Helena from 1805 to 1811 recorded the stranding there of seeds of *Entada*, *Caesalpinia*, and *Ipomoea Pes-caprae*. James Backhouse during a stay in 1838 in Mauritius referred to *Hibiscus*, *tiliaceus*, *Thespesia populnea*, *Terminalia catappa*, *Ipomoea Pes-caprae*, and other strand plants, all well-known sea-dispersed species.

W. B. Hemsley examined the previously known drift-seed material, as well as that collected during the Challenger expedition, and published his conclusions in 1885 in the Challenger Reports. He mentioned the following seeds collected on various coasts:—*Dioclea reflexa* from Tristan da Cunha; *Caesalpinia crista* from Kaffraria, Tristan, and St. Helena; *Entada scandens* from St. Helena; *Mucuna* sp. from Kaffraria (Hutton); *Mucuna* spp. from East Africa (Kirk), and seeds from the Azores (Darwin). All or most of these are now in Museum I at Kew, and will be reviewed later in this chapter. Darwin's collection seemed to me to be made up of a seed of *Dioclea reflexa* and three seeds of *Mucuna altissima*.

In 1910 the writer contributed notes on the popular names of some of these seeds to a South African dictionary, and from 1929 onwards issued a number of short papers on the South African alien drift. Guppy quoted some of the Challenger references in his "*Plants, Seeds, and Currents*", published in 1917, but without adding anything to them. Several South African writers have mentioned the seeds of *Entada* and *Caesalpinia* washed up on our coasts as examples of oceanic seed-dispersal with no further comment. R. Marloth has made references to the germination of drift-seeds of *Caesalpinia crista* and *Barringtonia racemosa* in conservatories at the Capetown Municipal Gardens and Port Elizabeth respectively.

### Folk-lore.

The European folk-lore of drift-seeds has been reviewed by Guppy, N. Colgan having devoted special attention to that of Ireland. The writer has done the same for certain seeds washed up in South Africa. It may here be added that *Entada* seeds are, in Angola, hung round the neck as a native fetish against sickness (Monteiro), and that in Moçambique seeds of *Caesalpinia* are used by various tribes as counters in a game and the pods as rattles for children. In West Africa the seeds of *Dioclea reflexa* make, as I saw, excellent peg-tops. At Kew I saw a seed of *Mucuna urens* with a thong attached which had been used as a charm; and they are carried by natives all over Africa for this purpose.

### Distances Travelled by the Floating Seed.

The length of the course travelled by the current-borne seed is always uncertain as the course of the current does not represent the actual geographical distance between the points of departure and arrival. The following estimates between Still Bay on the RIVERSDALE coast and other stations give nevertheless a rough idea:—Mossel Bay 50 miles; Port Elizabeth 236; East London 367; Durban 620;



Lourenço Marques 920; Beira 1,404; Zanzibar 2,446; Cape Agulhas 90; Capetown 192; Fuegia about 4,800; Durban to Mauritius 1,563; Keelings about 3,900; Java about 4,400; West Australia about 4,500; Sumbawa to Equatorial Africa 4,500; between Madagascar and the mainland of Africa from 250 to 600 miles; Capetown to Walvis Bay 715, Lobito Bay 1,437, St. Helena 1,631, Ascension 2,331.

### *General Consideration of the Seed-drift.*

The beach drift in South Africa varies in appearance and composition according to whether it is near, or at a greater distance from, an estuary.

In the former situation it is usually a sharply-defined ridge from a few inches to a foot high but much higher after floods, brown in colour, and consisting of material mainly from the interior.

Two or three miles away from an estuary, however, material of marine origin preponderates. There are usually several subsidiary lines of drift made up of logs, sticks, bark, marine *algae*, ascidians, cuttle-bone, and the egg-cases of molluscs and fish. The chief objects of vegetal origin first noted are perhaps fruits of *Scaevola Plumieri*, corms of *Iridaceae*, underground tuber-like masses from *Rhoicissus Thunbergii*, and the fruiting stems of *Anthericum revolutum*. At the highest drift-level lie pumice, slag from steamer furnaces, fragments of coral, cancellous bone from whaling stations, charred wood: terrestrial shells such as *Trophidophora ligata*, *Helix pisana*, and *Achatina zebra*; marine shells of the genera *Patella*, *Oxystele*, *Helcion*, *Siphonaria*, *Litorium*, *Turbo*, *Megatabennus*, *Conus*, *Haliotis*, *Ovulum*, *Cypraea*, and a host of others. The shells of *Spirula Peronii* are also common, a genus which here and in the West Indies coincides with the zone wherein all drift-seeds are eventually found. After the first impression multitudes of seeds, large and small, may on closer inspection be detected.

On many South African beaches such as those on the Riversdale coast, three classes of drift-seeds may be distinguished according to origin:—

- (1) Local South African. These come from the inland marshes, river banks, and the local strand vegetation:—*Ricinus communis*, *Datura Stramonium*, *Olea* spp., *Acacia saligna*, *A. karroo*, *Sideroxylon inerme*, *Scaevola Plumieri* and many others mostly, with the exception of the last-named, small and non-buoyant. Acorns and maize-cobs are abundant, also the stones of cultivated fruits such as peach, plum, and apricot. Brazil, Barcelona, Kentish filbert and other nuts, as well as those of *Castanea vulgaris* mostly arrive from passing ships. All of these have been noted by other writers in the beach-drift of many parts of the world.
- (2) Non-local South African. These come from as far eastwards as the north-eastern corner of the Union:—Seeds of *Ipomoea Pes-caprae*; fruits of *Podocarpus falcata* and *Cassytha filiformis*; pieces of the pods of *Cassia fistulata*; dead fruits or seeds of *Cryptocarya latifolia*, *Encephalartos* spp., *Pachystigma* sp., and *Trapa bispinosa*; viable

seeds of *Caesalpinia crista*, *Entada gigas*, *Canavalia obtusifolia*, *Hibiscus tiliaceus*, and *Thespesia populnea*, and fruits of *Barringtonia racemosa*, the last more often than not, dead.

- (3) Alien. The seeds arriving on the Riversdale coast from beyond the limits of the Union of South Africa are set forth in Table I, but there remain a number of smaller ones which are not therein recorded.

It may be mentioned here that on one occasion during a walk at Still Bay with Dr. I. B. Pole-Evans pieces of the aerial roots of a species of *Pandanus* were picked up by us in the drift.

### *Miscellaneous Materials in the Beach Drift.*

The ova of *Gasteropoda* and *Cephalopoda*, corals of *Watsonia* and *Antholyza*, segments of the rhizomes of *Cyperaceae*, the shining golden-yellow cysts of *Margarodes* sp., the floats of marine *Algae*, and even the core of a golf ball have been submitted to the writer as possibly alien sea-dispersed seeds. It is interesting to record that the error of confusing the egg-cases of the dogfish and the skate mentioned by C. Clusius (*Exotici*, 336) as far back as 1605, is not infrequently made to-day by the uninitiated.

A large, very buoyant piece of crude rubber from some port in East Africa or Madagascar was picked up on the Riversdale coast and is in the writer's collection. Derelict electric light bulbs, found also by Guppy in West Indian drift, are occasionally picked up unbroken. Some of these are of a type not used, as far as could be ascertained, in our local towns and villages: one, however, is marked "Union-Castle Line", and was found near Still Bay.

### *Sources of the Alien Drift.*

It is possible to define with a fair degree of accuracy the sources of most of the species of alien seeds which reach our shores. Most of the fruits of *Barringtonia asiatica* (*B. speciosa*) must come from Madagascar and its islands. Since, however, collections of this tree from Pemba are to be seen at Kew, assertions in older (and even later) works that it is absent from the African mainland may require confirmation. Inspector A. Ledreux of Tamatave, after receiving from me certain South African drift seeds, sought for and found identical seeds in the estuarine drift of Madagascar. I was able to determine these at Kew as belonging to *Mucuna myriaptera* (a Madagascar plant) and *Dioclea reflexa*. Seeds of *Intsia bijuga* are very common in our drift, of which Madagascar is by far the most likely source. It must be borne in mind that the coast-line of that island is longer than that of the Union of South Africa.

Encrustations of polyzoa, *Balanus*, and other marine organisms on a seed have been regarded as signs of a long ocean traverse. They may, however, be evidence merely of a long sojourn in the sea. The worn appearance of some may be due not to wave-action on the high seas, but be caused after arrival by friction of sand, shingle or rock and long exposure to wind and weather. Sometimes our knowledge

of phytogeography is of assistance, although with increased exploration some plants reveal an increased area of distribution. Effective sea-dispersal is, moreover, always progressing.

Drift-seeds from Madagascar seem, as far as my experience goes, to be more numerous on our coasts west of the East London Division than to the east and north-east of that point.

As to the time required by the floating seed to travel from Madagascar to South Africa it may be noted that the derelict steamship, "King Cadwallon", drifted less than half the distance in about seven weeks. From records of the German Admiralty, which I consulted in the British Museum, it appears that bottle No. 11 of Schott's series travelled from 26° 54·5' Lat. S. and 46° 27·9' Long. E. to near Plettenberg Bay, a distance of 1,269 sea-miles in 161 days or 7·9 miles per day, the duration including the time it lay on the beach before discovery. Under test conditions in a room at Riversdale 53 per cent. of fresh seeds of *Intsia bijuga*, sent me by the Service de l'Agriculture of Madagascar, were after 184 days still afloat. Of a parcel of seeds from the estuarine beach drift kindly collected for me by Inspector Ledreux, five each of *Dioclea reflexa* (spotted form), *Mucuna myriaptera*, and *Dioclea reflexa* (unspotted form) were similarly tested. All of these except three of the last were still floating after 500 days, when the experiment was stopped. The traverse of seeds across the Indian Ocean from south of Sumbawa to East Africa may, it has been stated, take eight months according to the season of the year. (Guppy, *P. S. & C.* 303). —

#### *Condition of Seeds on Arrival.*

Less than 1·5 per cent. of alien seeds arrive in South Africa in a damaged state. Those of *Xylocarpus* spp. are when they reach the Riversdale coast completely decayed, only portions of the outer shell remaining. Fruits of *Barringtonia asiatica* suffer greatly and only two out of seven are in good condition: the others are so much eroded that the "stones" are exposed. Those of *B. racemosa* also stand a long sea-journey badly. In both species sieve-like borings are not uncommon. A seed of *Entada gigas* (Muir 338) shows extensive lacerations probably caused by a fish, although these are not so deep as to prevent the seed reaching the shore. Seeds of *Caesalpinia crista* in some instances have black areas due to damaged cuticle, which in most cases leads to softening and sinking. A drift-fruit of *Heritiera littoralis* was represented merely by the separated halves of the shell. With a few exceptions noted later, alien seeds seem sound and probably germinable. Many or most are fresh-looking; but others are much worn, and bear the polyzoon *Nitscheina tuberculata*, cirrhipedes, or tubiculous polychaete annelids. A fair proportion of seeds sink in fresh but float in sea-water when tested after arrival, a sign that the period of buoyancy has almost reached its limit.

#### *Nitscheina (Membranipora) tuberculata* Bosc.

This polyzoon, identified for me by Mr. Farran of the Department of Fisheries, Dublin, has been found on specimens of every species of seed and washed up on the Riversdale coast as a partial or complete white investment. It has been recorded from the North

and South Atlantic (including Angola), the Indian Ocean, near the Philippines, etc., on floating *Algae*. It is more abundant in the tropics and does not pass the polar circles. (Cann & Bassler, *Bryozoa of the Philippines*). Many drift seeds seem well suited to the transport of spores of marine cryptogams.

### *Meteorological Conditions Influencing Arrival of Seeds.*

Although seeds may arrive at any time in South Africa, it has been found as a practical point that the best time to look for them is from September to March, after the south-east winds and westerly gales which assist in casting up floating material. This does not necessarily imply that there are more seeds in the sea at these times, but refers merely to the mechanical action by which all flotsam is then driven on and up the beach. Guppy advances the opinion that drift flows north of Madagascar during the south-west monsoon, and south of it during the north-east monsoon (*P. S. & C.* 304.) On the Keelings vegetable drift arrives mainly during December and January, when variable westerly, northerly, and north-easterly winds interrupt the more steady trade-wind. (*J. Vict. Inst.* 1890, 291). During the time that I was systematically cleaning up the beaches for seeds I have noted their arrival at intervals from September to March after many of the tides.

Guppy has reported the finding of seeds of *Entada* in the early part of the year on the south coast of Devon, a time which corresponded with the arrival of large quantities of *Physalia*. The drifting of *Physalia* and *Vecllae* on the coasts seems to be common at this time, and has been attributed to high winds from the Atlantic. (*P. S. & C.* 28-9). The coast of False Bay in South Africa is often, during the period September to March, strewn after gales with *Physalia*, and it is then a good time to search for uncommon fishes on the west of the Cape Peninsula. Similarly, an eminent Professor of Zoology, during a walk with me in September along the Riversdale coast, commented on the prevalence on the beaches of *Vecllae*, *Physalia*, and *Porpita*. As already stated that month is a good one for searching for alien drift-seeds.

### *Ineffectiveness of Alien Seed Dispersal in South Africa.*

With the possible exception of *Calystegia Soldanella* I have not observed that any foreign sea-borne seed has gained a footing, especially on the more temperate portions of our coasts. The appearance of seedlings of *Ipomoea Pes-caprae* and *Canavalia obtusifolia* on the shores of Riversdale from drift-seeds is in a different category, since the source of these is almost certainly South African. This failure is not due to absence of germinability, as I have raised plants of *Intsia bijuga*, *Caesalpinia crista*, *Mucuna myriaptera*, and *Dioclea reflexa* from drift-seeds planted in the open air at Riversdale. A. W. Buckland reports that a fruit of *Barringtonia asiatica* from the South African drift, when grown in soil, reached a height of four feet. [*Nature*, Vol. 38 (May-Oct.), 1888, p. 245]. Failure of a seed to germinate may among other causes be due to (1) lost or impaired viability from prolonged immersion, (2) injuries, erosion, or decay, (3) unsuitable soil or climatic conditions. Mud-flat, riverine, estuarine, and sandy beach species on reaching a new

locality require their own special habitats. Drift-seeds may, moreover, lie for years on the shore uncovered by soil. Many in order to reach a favourable site would have to gain a position behind the flood-mark, which is often difficult or even impossible; and even if successful in so doing they may still remain exposed, or other unfavourable factors may persist. South African climatic and soil conditions on the sea-shore are nearly always unsuited to the germination of tropical drift-seeds. Unstable local strand conditions are also a cause of failure with many seeds even of South African origin.

But, although the success of a tropical drift-seed in gaining a footing in South Africa would be probably fortuitous and at most temporary, the case in tropical East Africa may be, and probably is, different. In the older books on plant dispersal the Seychelles, Mascarenes, and Madagascar are frequently regarded as the western limits of certain sea-dispersed species. These species, however, are now known to occur on the coast of East Africa, and collections from there are in the Kew Herbarium. *Scaevola frutescens* and *Mucuna gigantea* undoubtedly occur wild and have been brought by currents, but the others mentioned presently have probably, in the areas quoted, been introduced by man. Further exploration of the coast may afford more definite evidence. The following are a few examples:—

1. *Calophyllum inophyllum* L.:—Moçambique, Zanzibar, Pemba. I should suspect man here as the probable agent. It is certainly introduced in West Africa, as the agency of the currents which disperse it can there be excluded.
2. *Barringtonia asiatica* Kurz: Pemba, "a fairly common tree growing on the sea shore". Schimper gives East African Islands, but H. N. Ridley does not mention East Africa.
3. *Erythrina fusca* Lour. (*E. ovalifolia* Roxb.): Pemba. An account of this species has been published by Dr. T. A. Sprague, who informed me at Kew that he considered it as probably introduced into Pemba by currents. It is, however, planted as a shade tree for coffee and cocoa as well as for ornament in some parts of the world, and is moreover, not a true strand plant.
4. *Mucuna gigantea* DC.: Cultivated at Pemba. My collections of *M. quadrialata* Baker from Moçambique, where it occurs in the wild state, prove that these are conspecific. It is not mentioned from East Africa by Schimper or Ridley.
5. *Scaevola frutescens* Krause (*S. Koenigii* Vahl): Zanzibar, Pemba Island, and Mombasa. It is unrecorded from East Africa by K. Krause in his monograph. (*Pflanzr.* IV, 1912, 120.)
6. *Cerbera manghas* L.: Zanzibar, Pemba. Schimper gives the Seychelles, but Ridley does not record it from East Africa.

#### AN ANALYSIS OF 1,000 ALIEN DRIFT-SEEDS.

For the purposes of this inquiry a consecutive series of one thousand seeds (Table I) was collected, mainly on the Riversdale beaches between the mouths of the Duivenhoks and Gouritz Rivers,

a strip of temperate coast about forty miles long as the crow flies, but much longer and difficult to estimate if the indentations are taken into account. That some of the seeds of *Caesalpinia* and *Entada* may have come from the north-east corner of South Africa is the only fallacy in the analysis. Some smaller tropical seeds are also found such as those of *Colubrina asiatica* and *Suriana maritima*. The preponderance of seeds of *Leguminosae*—which surpass all others in vitality—is noteworthy.

TABLE I.

Name.	Number.	%
<i>Caesalpinia crista</i> .....	295	29.5
<i>Dioclea reflexa</i> .....	177	17.7
<i>Intsia bijuga</i> .....	173	17.3
<i>Entada gigas</i> .....	131	13.1
<i>Mucuna gigantea</i> .....	80	8.0
<i>Mucuna myriaptera</i> .....	56	5.6
<i>Sophora tomentosa</i> .....	27	2.7
<i>Erythrina variegata</i> .....	13	1.3
<i>Ipomoea</i> sp.....	9	0.9
<i>Xylocarpus</i> spp. ....	7	0.7
<i>Barringtonia asiatica</i> .....	6	0.6
<i>Cocos nucifera</i> .....	6	0.6
<i>Strongylodon ruber</i> .....	4	0.4
<i>Erythrina fusca</i> .....	3	0.3
<i>Aleurites triloba</i> .....	3	0.3
<i>Hernandia peltata</i> .....	3	0.3
<i>Mucuna</i> sp. (Muir 504).....	3	0.3
<i>Heritiera littoralis</i> .....	2	0.2
<i>Mucuna</i> sp. (Muir 806).....	1	0.1
<i>Mucuna</i> sp. (Muir 238).....	1	0.1
	1,000	100.0

When a seed is able to resist penetration by water for weeks or months it is considered to be impermeable. Following Guppy's classification of seeds according to this standard, South African alien drift seeds may be divided into:—

1. Impermeable: *Caesalpinia crista*, *Dioclea reflexa*, *Intsia bijuga*, *Entada gigas*, *Mucuna* spp., *Sophora tomentosa*, *Strongylodon ruber*.
2. Permeable: *Barringtonia asiatica*, etc.
3. Variable, i.e. possessing both impermeable and permeable seeds: *Erythrina variegata*, *E. fusca*.

Here again seeds of *Leguminosae* predominate.

These alien seeds will next be considered in detail; it being, however, premised that, unless otherwise stated, the experimental results, remarks, and descriptions are applicable only to South African drift-seeds or to material obtained directly from the East African coast or from Madagascar.

#### *Caesalpinia crista* L.

At Lourenço Marques this shrub is common near the sea on and behind the foremost low dune, which is also its position in Java.

But it also occurs, although less frequently, in the outer border of the mangrove. I have seen drift-seeds from many parts of the South African coast between Namaqualand and Delagoa Bay, as well as from Tristan da Cunha and St. Helena. Of 70 fresh seeds collected in August, 1929, at Catembe, near Lourenço Marques, all were initially buoyant in fresh water; and the same was true of 300 seeds picked up by me in July, 1931, from the ground under the parent shrubs in the same locality. Of a third series of 123 ripe seeds collected by me from the pods near Polana seven sank instantly in fresh water.

Nine to ten fresh seeds weigh an ounce. In the drift state they weigh about eleven to the ounce, and are in colour leaden, grey, nearly white, or pale marble. In the pod, when immature, they are first yellowish-green and later olive, becoming when mature leaden or greyish.

Of 70 fresh buoyant seeds all except five had rattling kernels. Of 153 drift-seeds from the Riversdale coast 115 rattled and 38 were "silent"; of the 115 rattlers 109 floated in fresh water, 6 sank in fresh but floated in sea-water, and none sank in both mediums. Of the 38 "silent" seeds 25 floated in fresh water, 13 sank in fresh but floated in sea-water, and none sank in both mediums.

Both fresh and stranded seeds show a very high degree of impermeability. Fresh seeds sown on 11th November, 1929, were exhumed unaltered on 3 February, 1930; others, also fresh, were submerged in the sea at Still Bay in a perforated box for four months without change; a third series of fresh seeds floated in my study for 455 days when the experiment was stopped.

When the exhumed seeds mentioned above were filed and resown in a garden in the open air on 3rd February, 1930, one, a rattler, germinated after 28 and another, a non-rattler, after 22 days. The first attained a height of twelve inches but died during the following winter. The other flourished until January, 1934—thus for nearly four years—when it died owing to the roots reaching tough clay. It was during the later stages protected against frost by sacking, but actually experienced frost on several occasions without protection. I have succeeded in getting drift-seeds to grow on several other occasions. Rattling does not seem, therefore, always to be a sign of broken kernels or of other unsoundness preventing germination. My figures of the prevalence of rattling seeds do not quite agree with statements made by Professor Schimper (*Indo-mal. S.F.*, p. 164, and by Dr. Guppy *N.P.* II, p. 194), about seeds of *Cacsalpinia bonducella* from Indo-malaya and elsewhere. In some silent seeds which I have dissected the kernels were almost entirely separated by cavities from the testas. In Lagos I found that the majority of fresh seeds rattled. Three of my drift-seeds belong to *C. sepiaria* Roxb., but none to *C. Bonduc* Roxb.: neither of these is a strand plant.

*Dioclea reflexa* Hook f.

No South African alien drift-seeds vary so much in shape, size and colour as those of this species; but it is not difficult to bring them under one category by comparison of a large collection with fresh and drift specimens from the East and West Indies and from West Africa.

Two exhibits in Museum I at Kew, classic because they are mentioned by Hemsley in the Challenger Reports, interesting because they come from South and East Africa respectively, must first be considered.

The first comprises three seeds and is labelled "Seeds of *Mucuna* sp. Thrown up on the coast of Kaffraria. H. Hutton, Esq.". These seem to me to belong to *Mucuna gigantea* (a very dark or black seed), *M. gigantea* (brown, unspotted), and to *Dioclea reflexa* respectively.

The second bottle contains two seeds and is labelled, "Seeds of two species of *Mucuna* washed ashore on the East Coast of Africa". They were collected by Sir John Kirk. But one is undoubtedly *Dioclea reflexa*, and the other in all probability belongs to *Strongylodon ruber*, being similar to seeds which occur also, although rarely, in the South African drift.

*Dioclea javanica* Benth., and *D. Fergusonii* Thw., are synonyms of *D. reflexa* Hook. f.

Undoubted seeds of *Dioclea reflexa* from the Keeling drift are in Museum I at Kew under the name *Mucuna macrocarpa* Wall., and others on the authority of Treub under *M. macrophylla* Miq.

In Museum I, in Guppy's Keeling drift-collections, there is a group of eight seeds, with the following note on the back of the box in the writing of that collector:—" *Mucuna* spp. various: possibly not all *Mucunas*". It is probably that referred to by Guppy (*Viet. Inst.*, 1890, p. 290) as "*Mucuna* spp.? (3 or 4)", and quoted by Schimper (*Indo-mal. S.F.*, 1891) as "*Mucuna* sp. (3-4)". As far as it was possible to judge without opening the box and removing the glued specimens, these appeared to me to be:—

<i>Dioclea reflexa</i> , flat brown type ... ..	2
<i>Mucuna gigantea</i> ... ..	3
<i>Mucuna</i> sp or (?) <i>Dioclea reflexa</i> ... ..	1
<i>Dioclea reflexa</i> , like my 247, and the only other seed like it which I have seen ... ..	1
<i>Mucuna</i> or (?) <i>Dioclea reflexa</i> , but different from the third on the list ... ..	1

One of these, however, may possibly be *Mucuna acuminata*, a Javanese species of which I have seeds given me by Dr. D. van Slooten, and concerning which C. A. Backer remarks, "The reproduction is effected by the seeds which seem sometimes to possess floating power, sometimes not". (*The Problem of Krakatao*, 1929, p. 135.) Yet, in spite of this failure to recognise two undoubted seeds of *Dioclea reflexa*, there is another Keeling drift seed in Guppy's collections definitely and correctly named *Dioclea reflexa*, which is the same as those first mentioned among the eight seeds referred to above.

I have seen in a different collection at Kew a seed of *Dioclea reflexa* (unspotted) included in an exhibit labelled *M. urens* DC., in which the other seeds were correctly determined. It is possible that certain seeds from the Pacific labelled as *Dioclea* sp. may be *D. violacea* Mart., but that is a question going too far beyond the scope of this paper.



South African drift-seeds show the following colour-forms, distinguished here to admit of comparison with West Indian, West African, Madagascar, and East Indian seeds, fresh or from the drift:

1. Various shades of brown or mahogany, unspotted, or occasionally with indistinct darker blotches, but not distinct concrete maculae. These are common. Many others are black, which has been regarded by some writers as the final stage of the coloration process. Other seeds, not very uncommon, are unspotted, and of some shade of red.
2. Black-spotted on a reddish-brown ground; very numerous. Guppy regarded these as showing a partial failure of the colouring process. (*Studies in S. & F.*, 1912, 378-9). These two main colour-forms will now be considered in greater detail.

### *The Unspotted Form.*

Since there is some lack of uniformity in shape, shown also by Madagascar seeds sent to me by Inspector A. Ledreux, a further subdivision is useful; but they merge into one another by intermediate examples:—

- (a) Reniform, upper border indented, one side often squarish.
- (b) Intermediate between (a) and (c), not markedly rounded, upper border straight, one side often squarish.
- (c) Upper border more rounded, outline tending towards the circular.

In (a) the seeds measure about 30-33 mm. transversely, 23-28 mm. in breadth, and 11-16 mm. in thickness.

In (b) they are 29-30 mm., 24-25 mm., and 11-13 mm.

In (c) they are 24-33 mm. in diameter, and 10-15 mm. in thickness.

In practically all cases they are compressed and the great majority biconvex. The hilum is straight or slightly sinuous, usually acute, not indented, 1.5-2.5 mm. broad. The weight ranges from 68-93 grains. All, except three or four which are chipped or injured, appear sound and germinable. Some, however, which I sowed in the open at Riversdale, failed to germinate, owing probably to faulty experimental conditions. Many have encrusting polyzoa. There are none with loose kernels, or which on dissection showed internal cavities. The testas are less than 1 mm. thick.

Of four South African drift-seeds tested in fresh water at Riversdale for buoyancy one sank after 11, and one after 63 days, but two were still afloat after 121 days.

Of eleven seeds of this type received from Mons. Ledreux from Madagascar all floated initially in fresh water. Five were then tested further in the same medium, of which one sank on the 47th and another on the 113th day. A third germinated in water in my room on the 249th day, developed rootlets  $2\frac{1}{2}$  inches long, and was

removed on the 270th day, when it was still afloat. It has been preserved as a herbarium specimen. The two remaining seeds were still buoyant after 500 days, when the test was brought to an end.

A number of drift-seeds, of which the type in Muir 7-8, were at first difficult to classify, but after sufficient drift material became available were found to belong to this form. They are thick, almost semi-globose, measuring on an average 26-28 mm. transversely, 24-27 mm. in breadth, and 16-19 mm. in thickness. They weigh from 82-116 grains, and differ from the more common forms in no essential particular. Large peripheral cavities are present in some and absent in others, but no intercotyledonary cavity was found. The kernels floated in fresh water for seven hours. A fair number of this massive form sink in fresh but not in sea-water.

### *The Spotted Form.*

This form is even more common in the South African drift than the previous one, and is more uniform in size, shape, and colour. They are biconvex, compressed (although less so than the typical unspotted form), thicker at the micropylar end and upper border, the latter being slightly concave or saddle-shaped. The hilum is straight or sinuous, more or less sharp, never subcate, lighter in colour than the body of the seed, with a medial line lighter still, 2 mm. broad, and encircling two-thirds of the circumference. They measure 26-28 mm. transversely, 21-22 mm. in breadth, and 13-15 mm. in thickness. They are very hard, with, especially below the hilum, one or two peripheral cavities but no central cavity, and fairly thin testas. Dissection of this form, as in the case of the other, shows that they are seeds of a *Dioclea* and not of a *Mucuna*, the kernels when detached floating for as long as twelve hours, but the testas without buoyancy. All were sound, without loose kernels and apparently germinable. Out of a first series of 44 Riversdale drift-seeds of this form all floated in sea-water and 42 in fresh water. A seed picked up in January, 1929, was sown on 26 August, 1930, in the open air, was dug up unaltered on 12 November, filed and again sown on the same day, and germinated 41 days later. The seedling attained a height of twelve inches before it died, and has been preserved as a herbarium specimen. The stem is pubescent with reddish hairs, and bears a reddish-tomentose, trifoliate leaf. The average weight of these spotted seeds is 58 grains.

Of 39 seeds of this form, found in Madagascar and sent to me by Mons. Ledreux, all floated initially in fresh water at Riversdale. Six of these, when tested further for buoyancy, remained afloat after 500 days, after which observations were stopped.

A specially large and thick example of this form is the seed Muir 247 from Jongensfontein on the Riversdale coast. It is unique as far as my collection goes, but has been mentioned as almost identical with one of Guppy's in the Keeling drift collections at Kew. The measurements are 27 by 28 by 22 mm., the seed being thus almost globular. The raphe is 3 mm. broad, slightly darker than the two parallel zones, but not black; and the weight is 117 grains. It floats in fresh and in sea-water, does not rattle, and is not encrusted with marine organisms.

It is sometimes difficult to realize on casual inspection that the spotted and unspotted forms found in the South African drift belong to the same species. They can, however, be matched absolutely with seeds of *Dioclea reflexa* from West Africa, the West Indies, and elsewhere. Nevertheless, the synonymy appears to show that botanists have not always considered the Indian Ocean and Atlantic coast species as conspecific. *Dioclea javanica* Benth. is, however, definitely a synonym of *D. reflexa* Hook. f.

The following notes are based on my large collections of South and West African drift-seeds of this species, which have been compared at Kew with others from the East and West Indies. [Seeds of *Dioclea reflexa* are an article of commerce in the native markets of Sekondi, Accra, and especially Lagos, where I visited the well-known "Medical Market" on three occasions; some of the seeds sold being from the creeper, others from the drift. In the Wuri River drift close to the town of Duala, and even in the public street facing the river, they may be picked up in enormous quantities. At Pointe-Noire they are extremely numerous. They are used as tops by children, being spun on their convex sides by the fingers of both hands, the aim being that one top must knock another off a mat. There is a native belief that seeds of *Mucuna urens* are the females and those of *Dioclea reflexa* the males of the same species! Some of my fellow-travellers at first mistook my seeds for mussels.]

Unspotted South African drift-seeds are identical with:—

1. Seeds named *D. reflexa*, sent me from Buitenzorg, Java.
2. Seeds at Kew from the Keelings, and in the National Museum, Dublin, from the same source, so named. My seeds were definitely named *D. javanica*, a synonym of *D. reflexa*, at Sibpur, Calcutta.
3. Seeds from the Anadamans and Colombo at Kew.
4. Seeds sent to me from Madagascar.
5. Seeds in a pod, R. Baron 2657 at Kew, named *Dioclea reflexa*; also from Madagascar.
6. Material from the West Indies at Kew.
7. Many seeds of *Dioclea reflexa* collected in West Africa; at Kew, etc.

I have seen one pod containing spotted seeds, and another with unspotted seeds, in both cases from Madagascar; and similarly pods from West Africa showing both colour forms; all authenticated at Kew.

Spotted South African drift-seeds are indistinguishable from:—

1. Material at the National Museum, Dublin, labelled by Guppy as *D. reflexa*; the only differences found by Miss Knowles being that theirs was slightly larger, thicker, and darker than those from South Africa which I submitted to her.
2. Seeds in a pod, and loose seeds sent to me from Madagascar.
3. Seeds from the West Indies, and British Guiana, at Kew.

4. Seeds at the British Museum, given and labelled by Guppy "No. 13 *Dioclea reflexa* from the beach drift of different West Indian Islands"; and another collection which was made in the Turks Islands.
5. Others at Kew, labelled "Pods and Seeds of *Dioclea reflexa*: Chall. Exped. Mr. Moseley 1874", with a note "common at Bahia, cast up on the shore at Tristan d'Acunha".
6. Many seeds of *Dioclea reflexa* collected by the writer in West Africa.

All colour forms of South African seeds of this species can therefore be matched by others from different parts of the world. The thinner flatter type of the Indian Ocean littoral may also be found on the Atlantic coast; and, conversely, the thicker more massive type of the latter is met with on the shores of the Indian Ocean.

Many of the seeds show deposits, including in one case an acorn barnacle.

The following note by Mons. Ledreux is of interest (*in litt.* 26.3.1934, author's translation):—"I am sending you *Dioclea* seeds by this mail. Thanks to your instructions I have been able to recognize these plants. They grow in reality on the banks of rivers and near the sea in sandy localities. I believe it is now the beginning of the flowering season. All the seeds, accordingly, which I send have been collected on the shore, at spots where the waves arrive only on exceptional occasions, and never very far from the mouth of a river. This voluble leguminous species is met with generally on the Viha, which is a marsh plant, *Typhonodorum madagascariense*".

*Dioclea reflexa* is not a strand plant, but grows on the higher reaches of estuaries and inland on river banks, the seeds falling or being swept into the water and carried down to the sea.

*Intsia bijuga* O. Ktze. (*Afzelia bijuga* A. Gray.)

Madagascar is the nearest locality to South Africa for this littoral tree, which has not yet been recorded from the African mainland. The seeds were not finally determined by the writer until a parcel of fresh material was obtained from the Department of Agriculture, Madagascar, through the late Mr. D. d'Emmerez de Charmoy, Director of Agriculture, Mauritius, after which a paper was published (Muir, *J. Journ. Med. Ass. S.A.*, 28.6.1930, p. 355). Seeds got for me by Mr. A. P. D. McClean from the Calcutta Gardens, and one from the Philippines, lent by Sir A. W. Hill, were less massive than mine, but were not absolutely identical therewith, although the resemblance was otherwise close. Dissection of my drift-seeds had previously suggested this species. I had also, after notching drift-seeds with a saw and sowing them, raised plants which agreed with the description. The period of germination was short, namely twenty-five days, and the leaves produced were paripinnately bijugate.

Guppy found (*N.P.* II 174) that out of 100 seeds from coast trees in Fiji, 47 floated in river and 70 in sea-water. My own figures for 100 fresh Madagascar seeds are 37 and 74 respectively. Out of 77 seeds stranded on the Riversdale coast 59 floated in fresh and all in

sea-water. Of the 19 fresh Calcutta seeds 7 floated in fresh water. Twenty-eight fresh Madagascar seeds which showed initial buoyancy in fresh water were tested further in sea-water. Two sank at the end of the 2nd, one on the 17th, 27th, 37th and 41st, two on the 49th, and one on the 68th day. Eighteen were afloat and sound after 135, sixteen after 154, and fifteen (or 53.5 per cent.) after 184 days. Half of Guppy's seeds floated after five months. Bottle No. 11 of Schott's series took, as already stated, 161 days for this journey. Thus many seeds are non-buoyant, and of those which float 7 per cent. would sink not far from the point of original departure. Exfoliation of the testa and admission of water occurred along fine transverse striae which constitute lines of weakness.

Guppy's coast-grown Fiji seeds measured 25-30 mm. and weighed 10 or 11 to the ounce. Of my fresh Madagascar seeds the largest weighed 112 and the smallest 54 grains; those from the Riversdale drift 90 and 50 grains; those from Calcutta only 34 and 13 grains, respectively. The Philippine seed weighed 48 grains. My Riversdale drift-seeds measured 25-35 mm. in length, 15-30 mm. in breadth, and 10-13 mm. in thickness.

The hilum is very short and linear: at the opposite end there is a minute protuberance as in seeds of *Afzelia quanzensis*. The drift-seeds appear sound: a rattling kernel in one case only: no internal cavities; the testas thin; many, as may be expected after so long a journey, encrusted (sometimes completely) with marine organisms especially *Nitscheina*.

Stranded seeds, sown on 3 February, 1930, in the open air at Riversdale, produced plants one of which on 14 April was fifteen and another nine inches high: they lived until the end of May.

The seeds are said to be edible but seemed to the writer tasteless.

*Entada gigas* Fawc. and Rendle (*E. scandens* Benth.).

The synonymy of this species will be referred to in a subsequent chapter in the synopsis of strand-plants. The view of most botanists has been that *E. scandens* Benth. is cosmopolitan within the tropics, and this view has been accepted by Schimper, Guppy and other students of oceanic seed-dispersal. A later opinion is that *E. scandens* is a mixture of species and by no means cosmopolitan. This, if correct, would make it impossible to correlate the results of buoyancy tests made hitherto by different observers in different parts of the world, and would revolutionize the study of the distribution and direction of its dispersal. The collections made by the writer in Mozambique were found by Mr. John Hutchinson definitely to belong to *E. gigas*. Guppy, writing in 1906 and 1917, apparently did not know of the occurrence of *E. scandens*, which is a synonym for *E. gigas*, in East Africa. V. S. Summerhayes points out that *E. scandens* has not been recorded from the Seychelles. But it occurs in Rodriguez, Madagascar, and in the north-east corner of the Union of South Africa. It may be assumed, therefore, that most of our South African drift-seeds belong to *E. gigas*. Booberg in his revision of Schimper's list of Malayan strand-plants quotes *E. scandens* under the name *E. phascoloides* Merr., and the exact synonymy is not yet settled.

While fresh mature seeds are usually reddish-brown, old drift-seeds may be very dark. Immature seeds are soft and white, becoming after exposure to the air—even in a room—first of all yellowish, then light-brown, and finally a reddish- or mahogany-brown. Of a large number of fresh seeds which I collected near Lourenço Marques, 80 per cent. floated initially in fresh and 94 per cent. in salt-water.

Approximately 24 per cent. of fresh seeds approached the circular and 76 per cent. the oblong, or more rectangular, or cuneiform shape; reniform and markedly cordate seeds were not noted and must be uncommon. Of drift seeds from the Riversdale coast the proportions were about 30 per cent. and 70 per cent. respectively. In certain leguminous species the seeds at the ends of a pod may be small and variously elongated, thus deviating from the more ordinary shapes; and it is just these which cause diagnostic difficulties in drift-seed study. Of Riversdale drift-seeds the circular form (excluding abnormally small seeds) measured 43-53 mm.; the other forms 55-60 mm. in length, and 42-45 mm. in breadth. Fifteen of the largest weighed one pound. Many were encrusted with *Nitscheina* and serpulids, and a few with acorn *Balani*. With few exceptions all were sound and apparently germinable, but where decay or erosion was commencing it was usually at the hilum. Of these drift-seeds 88.5 per cent. floated in fresh water and 99 per cent. in salt-water; only one lacerated specimen even after long drying sank in both mediums. Five had loose rattling kernels but normal intercotyledonary cavities, an experience which should be compared with a statement by Guppy (*N.P.* II, 194), who may not, however, have been dealing with the same species of *Entada*, if the taxonomic views already mentioned be accepted.

Five legumes collected in June and July at Vila Luiza, when they were still green and the seeds immature, measure from 29½ to 36½ inches in length, and have from 10 to 13 segments. The very thick integument begins to fissure and separate after about three weeks.

#### General Note on *Mucuna*.

In drift-seed work the seeds of species of the genus *Mucuna* have afforded more difficulties in identification than perhaps any others, so that a considerable number remains unnamed in museums and carpological collections.

With regard to our South African drift material the problems are not less onerous than those encountered by Schimper and by Guppy, who were unable to determine all seeds which they found. The crux of the matter, as far as we are concerned, is the correct naming of the Madagascar species. Unfortunately the collections from this region in the herbaria at Kew and Paris are scanty, and mostly without seeds, or seeds that are present are immature or very old. Some of the species described under separate names require to be united, and it is possible that there may be one or two awaiting discovery in their native haunts. All the South African drift-seeds belong to the §§ *Carpopogon* and *Citta*, but not to § *Stizolobium*—an important point.

The Madagascar members of the genus, as far as can be determined at present, are as follows:—

§ *Stizolobium*: no encircling hilum present.

1. *M. pruriens* L.: Professor Humbert regards *M. Humbloti* Drake as a synonym (*In. litt.* to Director, Royal Bot. Gds., Kew, 18.5.1935).
2. *M. berneriana* Baillon: according to Drake *M. axillaris* Baker is synonymous. (*M. comoroensis* Vatke is synonymous with *Psophocarpus palustris* Desv. and does not have an encircling hilum).

§ *Carpopogon*: encircling hilum present.

3. *M. gigantea* D.C. The seeds of this plant, which are highly buoyant, form an important basis on which the belief in the efficacy of ocean currents in seed-dispersal rests. But the known facts of the distribution of the plant as affecting Africa, Madagascar, Mauritius and the adjoining islands, and the Seychelles had always seemed to me chaotic and disconnected. When V. S. Summerhayes found that a plant of the Mascarenes and Seychelles, referred by J. G. Baker (*Flora of Maur. and Seych.*) to *Mucuna atropurpurea* DC., was really *M. gigantea* DC., it was an important advance, all the more valuable in that it was an observation made by a careful systematist who was not engaged in or influenced by, the study of seed-dispersal! [*Enum. Angiosp. Seych. Arch. J. L. S. (Zoology)*, 1931].

In 1931 I made collections of *M. quadrialata* Baker, in Moçambique, but could not see any difference between the seeds and those of *M. gigantea*, or between the descriptions of the plants as published. Eventually Mr. R. A. Dyer, after examination of my collections at Kew, found that the species were identical. (*K.B.* 9, 1931).

*M. gigantea* DC., is not recorded from Madagascar either by A. Grandidier and Drake del Castillo (*Hist. Nat. de Madagascar*, 1886-1902), or by J. Palacky (*Cat. Plant. Mad.*, 1906). On the other hand *M. Grerci* Drake is so given. But two collections in the Kew Herbarium, viz., Baron 6417! and Grévé 305! belong really to *M. gigantea* DC., although previously not so regarded; and both are from Madagascar. During my stay at Kew, Professor H. Humbert, of Paris, lent me seeds of *M. Grerci* Drake, from Madagascar collections, namely No. 4871! made by Perrier de la Bathie and No. 8178! by Decary. The seed of the former is black-spotted on a dark-brown ground, the other medium-brown, unspotted; both seeds are longer transversely, and buoyant. They can be duplicated by numerous South African drift specimens in my collection, and could not be distinguished from seeds of *M. gigantea* DC.

Moreover, *M. Grevei* Drake belongs to the § *Carpopogon*. As I suspected that these species were also conspecific, I requested that the type of *M. Grevei*, viz. Grevé 10, should be obtained from Paris. After my departure from Kew this was done by Dr. H. G. Schweickerdt on my behalf, who found that they were identical. This was doubly checked by the examination firstly, of collections by Grevé at Kew and secondly, of the type sent from Paris.

Thus certain apparently disconnected facts in the distribution of *M. gigantea* in East Africa and the African Islands fell into place, and a problem with deep implications placed on a firmer foundation. It is, however, unsolved or erroneous determinations of plants with seeds transportable by the sea which constitute one of the causes which have possibly led to the belittling of the value of the agency of currents in seed-dispersal.

§ *Citta*: encircling hilum present.

4. *M. myriaptera* Baker. Drake regards *M. paniculata* Baker as synonymous with this, and Professor H. Humbert (*in litt.* l.c.) considers it identical with *M. horrida* Baillón. Baker, in his description, stated that *M. myriaptera* is near his *M. paniculata* and also *M. flagellipes* Vog.

Baron 6689! at Kew, from Madagascar, may belong here, but is defective. The sheet of *M. myriaptera* at Kew—Barron 5801!—has a pod with good seeds; but that of the same collection in the Paris Herbarium, which was presented by Kew, has neither pods nor seeds. Only one herbarium specimen of *M. paniculata* Baker, has seeds, but they are too immature for comparison with drift-seeds. There is no collection available of *M. horrida* Baillon bearing seeds. As those on the sheet of *M. myriaptera* Baker agree well with a species of drift-seed washed up on the South African coast I have retained that name in the following pages, and disregarded the synonyms.

*M. urens* DC. is stated to be cosmopolitan in the tropics (Hutchinson and Dalziel, *Flora of W. Africa*), and it is sometimes cultivated, but I could find no record of its occurrence in Madagascar.

Ridley states:—"Guppy gives this plant (*M. urens*) as Polynesian, but I have seen no specimens from there, and the plant he refers to must be *M. gigantea* which is common there." (*Dispersal*, 1930, p. 274). Seeds of these species could hardly be mistaken for each other, and I have ample material of both from Hawaii. Guppy (*P.S. and C.*, 121) records *M. urens* from Hawaii, and American botanists there consider this *Mucuna* to be *M. urens*. I cannot distinguish the Hawaiian form from seeds of *M. urens* which I collected in West Africa.



There is a puzzling problem raised by one of Guppy's experiments, performed with seeds which he regarded as belonging to *Mucuna macrocarpa* Wall., collected in the beach-drift of the Keeling Islands, and which he found remained afloat from 60 to 100 days (*N.P.* 11, 81). Ridley remarks (*l.c.* 274):—"It is remarkable that (if the identification be correct) the plant has not appeared between India and Cocos-Keeling Island". *M. macrocarpa* is a species of Sikkim and the neighbouring Himalayan region, perhaps 2,800 miles distant from the Keelings.

My own explanation is as follows. In a drift-collection of Guppy's at Kew there are certain seeds labelled *M. macrocarpa*, which really belong to *Dioclea reflexa*. Some forms of the former certainly resemble seeds of the latter. I examined 29 seeds of *M. macrocarpa*, some collected by Gamble in Sikkim, some sent to me from Calcutta, and several from other sources, and all, with a single exception which was probably defective, showed absence of buoyancy. The seeds of *Dioclea reflexa* are, on the other hand, highly buoyant, and it is thus possible, even probable, that Guppy without knowing it was experimenting with seeds of *D. reflexa* and not with those of *M. macrocarpa*. Ridley's qualification and my own difficulty would in this case fall away. This question has a deeper significance than that one of mere systematics; and, as it has hitherto stood, tends to misconception of the part played by oceanic seed-dispersal, not only in this particular instance, but in a wider sense.

*Mucuna gigantea* DC. (§*Carpopogon*).

Seeds of this giant liane are fairly common in the South African drift, specimens in my collection having been found at Lamberts Bay, Struis Bay, and west to the mouth of the Bashee River. Although sent by Hutton and quoted by Hemsley in the Challenger's Reports many years ago, their identity long remained a mystery. In January, 1931, a parcel of seeds was received by the writer from Lourenço Marques among which were some of this unknown sort. An expedition to Moçambique resulted in my finding *Mucuna quadrialata* growing in the *Barringtonia*, and complete material of the plant showed that it is conspecific with *M. gigantea*.

The seeds are present in enormous quantities on the floor of the forest, in the drift of the Inkomati River below the forest, and on the shores of the Bahia de Lourenço Marques. Seeds were received later from the drift at Inhambane and Beira, so that this plant may also be found in these neighbourhoods.

The majority of fresh seeds are more or less circular in outline; others are slightly longer transversely or broadly cuneate. The circular seeds are about 25 mm. in diameter; the others 24-26 mm. transversely, by 22-24 mm., by 11-12 mm. in thickness. They are much compressed, biconvex, with the surfaces often indented; the raphe black,  $1\frac{1}{2}$ -2 mm. broad, sulcate, surrounding  $\frac{2}{3}$  to  $\frac{3}{4}$  of the circumference.

Within the pods on the lianes immature seeds are white, soft, and larger than when mature; but when removed undergo slow coloration in the air. Coloration is completed inside the drying, blackening pods, the seeds meanwhile shrinking in size. Mature

seeds are black-spotted on a drab or dull light-brown ground, which less commonly is slightly tinged with red. Others are leaden or dark-coloured with few or no spots. Uniformity and lightness of colour are more marked in seeds within the pods.

On the humid floor of the forest, where the seeds may lie for a period among damp rotting debris, the proportion of darker seeds increases, the ground-colour being a medium or darker reddish-brown or even black, so that the spots do not show up well or are merged in the general colour of the seed.

Fresh seeds floated in fresh water at Riversdale for 400 days, after which period the test was abandoned. None sank, but after 250 days one or two floated with one border downwards. Of 71 fresh seeds from the lianes all except eight floated initially; of 96 seeds taken from the floor of the *Barringtonia* forest all, except two, floated; of 109 seeds from the river-drift between the forest and the sea, but from a half to three miles from the former, all floated.

My Lourenço Marques seeds from the lianes and neighbouring river-drift show a great degree of uniformity in size, shape, and most other respects. They have, accordingly, been taken here as the standard of comparison for the determination of drift-seeds. The latter appear sound, and without injury or loose kernels. Deposits of marine organisms are frequent, affording with the worn state of the raphe evidence of a long sojourn in the sea and exposure to wind, weather, and friction. The kernel is white, and cavities are present extending round much of the periphery especially below the raphe. The testa, except at the hilum, is fairly thin. The kernel and the testas are non-buoyant, but a good deal of the latter floats from 8 up to 15 hours, provided that the fragments include part of the hilum with the subjacent aeriferous tissue. Seeds from the beach-drift at Riversdale and other stations are often very dark, as they have lain for years buried among refuse kept damp by spray, fogs and rain, or have been long exposed. Many are highly polished and without visible spots. The ground-colour on one side may be different from that on the other, the contrast in some cases being very marked.

Of many fresh Hawaiian seeds sent to me by G. P. Wilder some are unspotted, some black-spotted on a light- or reddish-brown ground, and one was nearly black with the remains of the reddish ground-colour still evident. They are not different in any essential particular from South African seeds.

#### *Mucuna myriaptera* Baker.

The type of drift-seed of this plant is Muir 16-17. At first it was considered at Calcutta and elsewhere to belong to *Strongylodon ruber*, but the seeds were found later by the writer not to agree. There are authentic specimens of *S. ruber* in the writer's collection from Ceylon, Fiji, and Hawaii and also a fair number at Kew. The source of our drift-seeds was cleared up beyond reasonable doubt when Inspector Ledreux, to whom South African drift material was sent for comparison, discovered them in quantities near estuaries on the shores of Madagascar. He was good enough to send me sixteen of these seeds. Their identity was established at Kew by comparison with seeds in a pod of a Madagascar collection, Baron 5801! Professor

Humbert of the Museum National d'Histoire Naturelle, Paris, wrote that they had no fruits or seeds of this species, their only material being a portion of Baron 5801! given to them by the Kew Herbarium.

On dissection South African drift-seeds and these sent by Mons. Ledreux are found to be identical. They have a large intercotyledonary cavity, belong to Guppy's second section of the first group of drift-seeds, and are indubitably those of a *Mucuna*. *Strongylodon ruber* on the other hand belongs to the second section of the second group. The kernels of this *Mucuna*, which are almost white or very pale yellow, have no independent buoyancy; and although pieces of the testa which include portions of the hilum float for three or four hours, the remaining fragments sink at once.

In other respects they are also absolutely identical. Of over a hundred drift-seeds which I have examined all are black or in a few cases dark brown, and never distinctly spotted; more or less compressed laterally, but sometimes semi- or almost globular. The largest are 25-27 mm. long, 23 mm. broad, 15-17 mm. thick, and weigh 71-82 grains; the smaller ones about 21-22 mm. long and broad, by 14-15 mm. thick, weighing 39-53 grains. The hilum is intensely black, 3 mm. broad, flat, and flush with the body of the seed, not sulcate.

All drift-seeds, as well as those received from Madagascar, float both in fresh and in sea-water. The results of buoyancy tests performed at Riversdale with Mons. Ledreux' seeds are as follows:—Of sixteen seeds all floated initially in fresh water; of five placed in fresh water all remained afloat in my room after 500 days, at which period the experiment was terminated.

A drift-seed from the Riversdale coast previously filed and sown in the open, but later kept under my verandah, germinated and appeared above ground on the 45th day. It did not, however, long survive. My seeds appear sound and germinable, none has a loose kernel, and a fair number have deposits of *Nitscheina*.

*Mucuna* sp. § *Citta*.

This is my seed No. 806 from Grootjongensfontein on the Riversdale coast. It is dark-spotted on a dark-red ground with exactly the colouring of seeds of *Mucuna flagellipes*, to which Baker says his species *M. myriaptera* is nearly allied. It has the rough rugose testa of seeds of *M. flagellipes*, *M. altissima*, and *M. urens*. The measurements are 24 mm. by 26 mm. by 22 mm. in thickness. The raphe is intensely black, flat, and about 4 mm. broad, occupying more than three-fourths of the circumference. It may be an aberrant form of *M. myriaptera* with arrested and incomplete coloration, which was also the opinion of others who saw it at Kew; but the ultimate decision awaits the procuring of further material. I have no other seed exactly like it, so that the fallacy of insufficient samples has to be kept in mind.

*Mucuna* sp. § *Citta*.

I have three specimens of this seed, Nos. 504, 910 and 1064, all picked up on the Riversdale coast within a few miles of one another. There is nothing like them at Kew or Paris, and in spite of every

endeavour they remain undetermined. They are thick massive seeds nearly circular in outline, black-spotted on a reddish-brown ground, 24.5-26.5 mm. long, 23-26.5 mm. broad, 15-17 mm. thick. The raphe is black, 4-5 mm. broad, and occupies only a little more than half the circumference, the ratio being 43.6 : 78.6. No. 504 was dissected, the kernel being found to sink instantly. Some pieces of testa, which included portions of the aeriferous tissue under the hilum, floated for twenty hours but the rest sank at once. These seeds, which in colouring resemble those of *Mucuna gigantea*, are very distinct from all others I have seen. They may belong to *M. horrida*, should that species later be proved to be distinct, or to another as yet undiscovered.

*Mucuna* or *Dioclea* sp. (Muir, 238).

This extraordinary seed was picked up by the writer at Morris Point on the Riversdale coast, and is the only specimen of the kind he has as yet seen. The colour is exactly that of seeds of *Entada gigas*, and it is also the largest leguminous drift-seed except that of *Entada*. It measures 34 by 37 by 24 mm. in thickness, weighs 232 grains, is buoyant in fresh and in salt-water, apparently sours, and does not rattle when shaken. The raphe is 4.5-8 mm. broad at different points, of the same colour as the body of the seed, and owing to some defect is not enclosed by the usual limiting border at one end. Probably it is an abnormal seed of *Dioclea reflexa*, or even of a *Mucuna*. As it is the only seed of the kind it has not been dissected, since this step would necessitate its destruction.

*Sophora tomentosa* L.

Seeds of this shrub, while fairly common in the Riversdale drift, are more so in the river and beach-drift around Lourenço Marques, near which it grows on the strand and coastal dunes of the mainland and off-shore inlands. Some of our drift-seeds, however, may come from Madagascar. When fresh seeds were tested by me for buoyancy in fresh water 48 per cent. were still afloat after 104 days. In the drift-state they are yellow, 7.5-8 mm. long, weigh about three grains, and are at first invariably mistaken by my young collectors for seeds of *Ipomoea Pes-caprae*. Guppy has recorded the results of tests made with *S. tomentosa* L. in the West Indies (*P.S. and C.*, 237-9). This species was, however, *S. occidentalis* L., so that his conclusions cannot be compared with the above. Eight seeds of *S. tomentosa* were found by the writer in one day within an area of 30 yards on the Riversdale coast.

*Erythrina variegata* L. var. *orientalis* Merr. (*Erythrina indica* Lamk.)

The writer is much indebted to Dr. van Slooten of Buitenzorg for fresh seeds of this strand species and of *E. fusca*; and to the Director of Agriculture, Suva, Fiji, for others of *E. variegata*. Both species of seeds occur in the Riversdale drift, and both are apparently illustrated but not specifically named by Schimper in his Indo-malayan Strand-flora. It is a native of the tropics of the Old World except Africa; and the seeds are dispersed not only by ocean currents, but also by man. Drift seeds are usually dark-red, measuring 13-15 mm. in length, 8-10 mm. in thickness, height of side 9-11 mm. Guppy found that they still remained afloat after five months. (*N.P.* II. 577.)

*Erythrina fusca* Lour. (*E. ovalifolia* Roxb.).

Drift-seeds of this tree, which is not a true strand plant, are less common on Riversdale beaches. They are longer and not quite so thick, viz. 15-18 mm. by 7·5-9·5 mm. by 7-10 mm. T. A. Sprague has recorded its appearance in late years in Pemba in East Africa. (K.B. 1909.)

There are specimens of prickles at Kew collected by Guppy in the drift of the Keelings, labelled *Erythrina spinæ*; and others much larger in the British Museum from the Turks Islands, also given by Guppy, named *Xanthoxylon* sp. I have found similar spines in the Riversdale drift, and also south of Pointe-Noire in French Equatorial Africa.

*Strongylodon ruber* Vogel (*S. lucidus* Seem.).

Three of my Riversdale drift-seeds agree well with fresh authenticated seeds from Ceylon and Fiji. Sir John Kirk's seed already referred to, from the East African drift, resembles closely my No. 439 from Riversdale. Dissection of my No. 863 shows that they belong to Guppy's second section of the second group. They are black with a narrow flat hilum, and measure as follows:—No. 439, which is almost spherical, 18 by 16 mm.; No. 1042 is 12 mm. long, by 20 mm. wide, by 19 mm. thick, No. 863 was 13·5 mm. long, by 20 mm. wide by 18·5 mm. thick. They appear to be extremely rare in our drift.

*Canavalia microcarpa* Piper (*C. turgida* Grah.).

Two or three Riversdale drift-seeds in my collection are indistinguishable from those of this species, which is common on the beaches of the Seychelles (Summerhayes), a characteristic beach plant of the Pacific (Guppy N.P. II, 581), but not a beach plant in Java, although twice collected there (G. Booberg). It is well known to be dispersed by ocean currents.

*Derris trifoliata* Lour. (*D. uliginosa* Benth.).

The fruits of this semi-climber of the outer mangrove and river-mouth swamps are numerous in the drift of the Inkomati River, the estuarine drift at Catembe, and the beach-drift at Polana, and at Beira, but are of local origin. These pods (and to some extent the seeds) are sea-dispersed, chartaceous, one-seeded, 35-40 mm. long, 22-25 mm. broad, and weigh 30-34 grains.

*Dialium Schlechteri* Harms.

This is a tall tree common near the banks of the Inkomati River. The indehiscent fruits, which are 9-10 lines long by 5 lines broad are eaten by man, apes, bats and birds, and contain an orange-coloured pulp with one or two seeds. These fruits are common in the river and beach-drift. Of 14 taken fresh from the tree and well dried, all floated initially in fresh water; one sank on the 9th, 12th, 13th and 14th day; and three were still afloat on the 36th day, but water had by that time entered near the attachment of the pedicel. The seeds are, however, non-buoyant. Dispersal is probably mainly brought about endozoically by animals, possibly to a small extent by rivers,

but not effectively by the sea. Buoyancy is due to the fruit-shell being insufficiently filled by the contents. The native name is "itiba".

*Cocos nucifera* L.

Coco-nuts, usually complete in the husk, are much more common in the Riversdale drift than would appear from Table I, but they are usually broken in pieces by the curious finder before I see them. I have never known of any of those found locally to be viable. One of the great questions in oceanic seed-dispersal is whether coco-nuts are effectively dispersed in this way. It may sometimes under favourable conditions occur, but man is the chief agent. The palm does not occur wild, but is cultivated in East Africa on the coast and inland.

*Ximenia americana* (Pl.) L.

This is a shrub or tree almost pantropical in the littoral vegetation and also sometimes occurring inland. In South Africa and Rhodesia *X. caffra* has, in the past, been mistaken for *X. americana*; but Dr. H. G. Schweickerdt, who has paid special attention to all the South African species, informed me that in all probability true *X. americana* does not occur within the Union or other parts of South Africa. He is of opinion that it may occur on the East Coast of Africa, although I have seen no material from there at Kew or elsewhere, and have not yet found fruits or "stones" thereof in the beach-drift. I possess excellent specimens for comparison in my collection from the Gold Coast and the East Indies. In the latter region it occurs exclusively on the strand in the *Barringtonia*. The distribution of *X. americana* based on an examination of the sheets at Kew is given in the synopsis at considerable length.

*Tacca leontopetaloides* (L.) O. Ktze.

This plant is more commonly quoted in seed-drift literature under the synonym *T. pinnatifida* J. & G. Forst. In many parts of the tropics it is a strand species with sea-dispersed buoyant seeds, but it is also found far inland due to cultivation and dispersal by man. There are collections at Kew from Zanzibar, Pemba, Tanganyika, Northern Rhodesia, Seychelles, Madagascar and the Comoros. In Kenya it occurs in grassland, bush or forest, and, as it is also often a stream-bank or marsh plant, the seeds may possibly reach the sea beaches by way of the rivers. I have not found them in our drift.

*Hernandia peltata* Meissn.

There are in my collection three "stones" from the Riversdale and one from the Port Alfred beach-drift, which agree exactly with fresh material at Kew, and with Guppy's specimens of *Hernandia peltata* from Keeling drift. The view advanced by Merrill that it is the same plant as *H. ovigera* L. has not met with universal acceptance.

The stones are most likely to be mistaken for those of *Sapindus saponaria*, which are considered by Hemsley to be ocean-dispersed, but the latter is not a native of South Africa although occasionally cultivated in gardens. *S. trifolius* and *S. Mukorossi* are cultivated

in India, and the fruits are imported into Natal for commercial purposes. I saw fruits at Kew which had been sent from Durban for identification. Fruits from some of these species may, therefore, be expected to appear in the South African drift, but they have not yet been found, and will then almost certainly be non-viable.

*Suriana maritima* L.

A few seeds which appear to belong to this have been found west of Still Bay. They have considerable capacity for sea-dispersal, but are very small and are doubtless overlooked. They may possibly be transported by logs and pumice. It grows in the Seychelles, Mascarenes, etc., but not in the Dutch East Indies.

*Xylocarpus moluccensis* (Lamk.) Roem.

Guppy has stated that the student of sea-dispersal cannot distinguish between the seeds of this tree and of *X. granatum* Koen (*P.S. & C.* 141). There is admittedly considerable confusion in botanical works with regard to these species and the size and appearance of their fruits. Fresh Seychelles material of seeds and fruits at Kew are distinguishable. Drift-seeds collected at Lourenço Marques, Muir 740!, were determined at Kew as belonging to *X. moluccensis* and agree well with fresh seeds in that Herbarium from the Seychelles. Seeds of a *Xylocarpus*, exactly like these, are also found in the Riversdale drift, but are mere shells destroyed by marine borers and occupied in some cases by the calcareous tubes of some animal. Many of the drift-seeds which I brought from Moçambique have germinated before or after arrival there. This tendency to germination in rivers and the sea limits their capacity for effective sea-dispersal. (*Cf. P. S. & C.* 142).

*X. granatum* Koen.

Some of the drift-seeds at Lourenço Marques belong to this species, as a few trees thereof grow in the immediate vicinity. They also agrees with fresh Seychelles material at Kew

*Aleurites triloba* Forst. (*A. moluccana* Willd.)

Seeds of this tree, which is not a strand species, are occasionally found in the South African drift, but in a non-viable condition. It is cultivated at Cape Town, in the eastern parts of the Union, and as a shade-tree in the streets of Lourenço Marques, Inhambane, etc. The writer agrees with Guppy that sound seeds do not appear to be transported by currents (*N.P.* II. 419).

*Jatropha Curcas* L.

At Vila Luisa in Portuguese East Africa these shrubs in places overhang the Inkomati River, and fruits and seeds, therefore, easily reach the river and sea-drift. I have also viable seeds from the beach-drift at Inhambane, from Dr. Stauffacher, and a dead seed, encrusted with *Nitscheina*, from Port Alfred collected by Mr. J. W. Phillips. Water plays no effective part in dispersal, the plant being cultivated by natives in the Transvaal, Moçambique, Angola and many other countries. All fresh seeds sank in water after 31 hours;

the capsules were still afloat on the 18th day although decayed; and when the seeds were then removed they were found to be without buoyancy. It is not a strand plant.

*Mangifera indica* L.

The "stones" in the Riversdale drift are mere fibro-membranous shells, and may have arrived in that state or been thrown overboard when fresh from coastwise shipping. They are abundant in the drift at Lourenço Marques, where the trees grow, and the fruits are an important article of diet. It is not, however, a strand species. Well-dried stones, six months old, tested at Riversdale, were all penetrated by water within five days and sank a few days later. Guppy has recorded one from the drift of South Wales. They could not be transported great distances by the sea and remain alive.

*Colubrina asiatica* Brongn.

A few undoubted seeds have been picked up on the Riversdale coast, which agree well with others kindly procured for me from Queensland by Professor R. H. Compton, and from the Philippines through Professor Fischer. They are probably often overlooked, and may be easily confused with seeds of the South African shrub *Noltia africana* Rich., which are plentiful. It is a strand-plant in Mozambique and other parts of the coast of East Africa.

*Heritiera littoralis* Ait.

These fruits are excessively rare in the Riversdale drift. Very interesting because of their far distant source—East Africa, Madagascar, and the Mascarenes—one found in September 1932 was dead, but a second picked up in December 1934 is apparently in good condition. It is a tree of the mangrove and estuaries of East Africa, etc.

*Terminalia catappa* L.

This tree has been introduced into cultivation in East and West Africa and widely in the tropics. I picked up a stone at Still Bay; and also drift fruits in Portuguese East Africa, the Gold Coast, the Cameroons, etc., which are, however, of local origin. The first was non-viable, the others more or less fresh.

*Barringtonia asiatica* Kurz. (*B. speciosa* Forst.)

Seven of these large mitriform fruits have been found on Riversdale beaches. One, Muir 658, is in fine condition, 14 inches in circumference at the base where the length of the diagonal is 5 inches, 4 inches in height, and 2½ ounces in weight. Another is in a fair state, but the others are deeply eroded. They probably come from Madagascar and its islands. There is a sheet of this at Kew from Pemba, Greenway 1468!, collected in February 1929.

*Ipomoea* sp.

These beautiful seeds, evidently belonging to one of the larger current-dispersed species of *Convolvulaceae*, have defied all efforts at precise determination, and are very rare in the South African drift.



They have exactly the colour of seeds of *Calonyction aculeatum*, are 11-13 mm. long, and the truncate basal surface is entirely occupied by a very large cordate hilum. They are sound, apparently germinable, and on some there are encrustations of *Nitscheina*. One was dissected by Mr. John Hutchinson, and another has been given to the Kew Museum. Muir 537-9, 1041, etc., are examples.

*Wedelia biflora* DC. (*Wollastonia glabrata* DC.)

It is found in Moçambique, Pemba, etc., on the strand often just above high water mark. The fruits are sea-dispersed, but I have not found them in the South African drift. They are very small and have doubtless been overlooked.

The fruit-cases and hypocotyls of *Rhizophoraceae* have not been observed in the drift at Riversdale, or indeed at any great distance from the creeks and sheltered estuaries on the African coast where the parent trees are stationed.

*Anacardium occidentale* L.

This tree is extensively cultivated near Lourenço Marques and in Portuguese East Africa generally, but does not occur on the beach. Nevertheless the fruits, known as cashew-nuts, are fairly frequent in my experiences in the drift at Delagoa Bay. A non-viable nut was found by Miss H. J. Muir on Umhlali Beach, Natal. Large numbers were tested by the writer and many were found to have an initial and very limited buoyancy; but they could not be transported far by sea without losing their germinability. Guppy considered a week to be the limit of flotation (*P.S. & C.* 174). They are eaten after being roasted and also used by natives of Moçambique to make an intoxicating liquor. We often saw there the ashes of old fires made for the purpose under the trees. Birds, bats, and apes also feed on them.

*Adansonia digitata* L.

The baobab reaches southwards to the northern Transvaal and is abundant in Rhodesia and Portuguese East Africa. The presence of two seeds in the Riversdale drift is very curious. They remained long undetermined, but were finally recognized by the writer at Kew. Their occurrence in the drift is accidental and of no significance as the tree does not occur on the beach.

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## CHAPTER II.

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### THE SEED-DRIFT AT VARIOUS STATIONS.

#### *Tropical West Africa.*

It was with a very special interest that I examined the seed-drift at a number of stations between Sierra Leone and French Equatorial Africa, which because of its similarity in nature and species to that of the West Indies concerns, as Guppy has said, "a subject which is intimately bound up with the dispersal of plants by currents across the Atlantic". Most of it is of local origin, with estuarine and river-bank *Leguminosae* predominating, e.g. *Dioclea reflexa* Hook. f., *Mucuna urens* DC. (*M. Sloanei* Fawc. & Rendle), and *Mucuna flagellipes* Vog.

The seeds of the last-mentioned species, which are indistinguishable from those of *M. altissima* DC. (*M. urens* Fawc. & Rendle) of the West Indies, are not mentioned in drift literature. Of 80 seeds of *M. flagellipes* from the Duala drift and 46 from Pointe-Noire, all floated initially in fresh water; and of 10 purchased in the native medical market at Lagos nine floated. Of 6 Duala seeds tested at Riversdale in fresh water, all were still afloat after 154 days. Of 5 Lagos seeds, initially buoyant, one sank during the test on the 45th day, the remainder being still afloat after 154 days. They could therefore make the ocean passage from West Africa to Brazil, and certainly retain viability.

On the beaches around Takoradi I found, in the drift, seeds of *Ipomoea Pes-caprae*, *Canavalia obtusifolia*, and, as everywhere on the West Coast, many kernels of *Elaeis guineensis*, but those of the *Leguminosae* cited above were uncommon.

At Accra fruits of *Saccoglottis gabonensis*, *Terminalia catappa*, and *Casuarina equisetifolia*, were picked up; but again the large seeds of *Leguminosae* were not numerous in the drift. As they are articles of commerce my samples of the last-named were, however, always recognized by the natives.

Nowhere were drift-seeds so abundant as at Duala and Pointe-Noire, where they were found on the beach at every step.

At Duala I found drift-seeds of *Dioclea reflexa* and *Mucuna flagellipes* in large quantities, but only one of *Mucuna urens* and none of *Caesalpinia crista*. Nineteen drift-seeds of *Physostigma venenosum* were obtained within a few hours, and also drift-seeds of the following:—*Ecastaphyllum Brownei* (the pods in the drift often quite fresh), *Drepanocarpus lunatus*, *Terminalia catappa*, *Entada gigas*, *Theobroma cacao*, and others.

At Pointe-Noire seeds of *Dioclea reflexa* and *Mucuna flagellipes* were just as plentiful, but only four seeds of *Mucuna urens* and one of *Physostigma* were picked up. Others belonged to:—*Saccoglottis gabonensis*, *Carapa procera*, *Elaeis guineensis*, *Ecastaphyllum Brownei*, *Drepanocarpus lunatus*, *Cocos nucifera*, *Scaevola Plumieri*, *Canavalia obtusifolia*, *Ipomoea* spp., *Terminalia catappa*, (?) *Ochrocarpus africanus*, and *Hyphaene thebaica*; also hypocotyls of *Rhizophora racemosa*. *Abrus precatorius*, as at Lourenço Marques, was abundant on the dunes, but the seeds did not reach the drift.

The above are mentioned to show the contrast with the seed-drift south of the Congo, where it becomes more and more scanty, and, in Angola, is derived chiefly from the vegetation concentrated around the mouths of the rivers.

At Loanda the main drift constituents originate from *Scaevola Plumieri*, *Canavalia obtusifolia*, *Ipomoea Pes-caprae*, *I. stolonifera*, *Cassipoua filiformis*, and *Casuarina equisetifolia*. *Cocos nucifera* is cultivated.

At Lobito I saw only *Casuarina* and *Scaevola*. *Chrysobalanus orbicularis* occurs on the coast, but no material was found, and the fruits could not be obtained and tested for buoyancy.

I have no seed-drift records from the desert area south of Mossamedes, but it is probably much the same as at Walvis Bay.

#### *Walvis Bay.*

The seed-drift at Walvis Bay and Swakopmund was found, in April and in September, to be scanty to an extreme degree. What there was had been brought down from the interior by former floods of the Kuiseb and Swakop Rivers, and consisted of seed of *Ricinus communis* (dead), a few of *Acanthosicyos horrida*, which are a food of Bushman and Hottentots, and pods of *Acacia Giraffae*. These pods are attacked by a moth, and although many of the seeds are viable most are eaten out by a weevil. One is here struck by the resemblance to the drift of the plantless or desert zone of northern Chile, where Guppy found here and there a few *Medicago* pods and some seeds of a large pumpkin—*Cucurbita*—a favourite food with the Chilean indigenes of the lower class. This similarity extends not only to paucity but to the botanical families. I found no alien sea-borne seeds and nobody recognized my stock samples with the exception of one harbour official, who had seen seeds of *Entada* and *Caesalpinia* on the south coast of South Africa.

#### *The South African West Coast.*

The writer possesses and has examined drift-seeds of *Entada gigas*, *Caesalpinia crista*, and *Dioclea reflexa* from stations ranging from Namaqualand to Hout Bay, Kommetjie, Noordhoek, and Slangkop in the Cape Peninsula. At Lamberts Bay he obtained seeds of *Entada*, *Caesalpinia*, *Mucuna gigantea*, and *M. myriaptera*, the last two brought by the Agulhas current from the Indian Ocean littoral round Cape Point. Fruits of *Grielum tenuifolium* are common there, but when tested sink within eleven hours. Fruits of *Polygonum maritimum*, also common, may float if still in their investment for three or four days. The nuts of *Heliotropium curassavicum* are non-buoyant but may possibly be transported by pumice and logs. The last at the time of my visit were abundant on the shore and pumice was also present. Seeds of *Osteospermum moniliferum* were common, but it grows close by.

#### *Struis Bay.*

I obtained here seeds of *Entada gigas*, *Caesalpinia crista*, *Intsia bijuga*, *Dioclea reflexa* (unspotted and spotted), and *Mucuna myriaptera*, which according to residents occur locally in that order of frequency. A few seeds of *Ipomoea Pes-caprae*, *Canavalia obtusifolia*, and *Scaevola Plumieri* brought by the current from further east were also picked up. This station is immediately east of Cape Agulhas. The local seed-drift was unimportant and not abundant.

#### *Riversdale Coast.*

The seed-drift of Riversdale beaches, which are typically temperate South African stations, has been described in the previous chapter, the alien seeds being given in Table I. A seedling of *Canavalia obtusifolia*, seedlings and plants of *Ipomoea Pes-caprae*, and fully grown flowering and seeding plants of *Calystegia Soldanella* from current-borne stranded seeds, have all appeared on this section of the coast. (Muir, J. *Kew Bull.* I. 1934).

In temperate regions especially the local seed-drift carried down by rivers is apt near the estuaries to mask the ocean-borne seed-drift. To illustrate this the agency of the Kafirkuils River in bringing down drift to the Riversdale coast at Still Bay after the great floods of November 1928 may be cited. Not only fruits, seeds, and other smaller vegetal matter were so transported, but railway construction plant, boats, ostriches, sheep, burrowing snakes (*Typhlops*), puff-adders and other *Ophidia*, lizards, tree-mice, scorpions, species of *Coleoptera*, and on previous occasions even a baboon or two (*Papio porcarius*).

The vegetal constituents were:—*Prionium serratum*, *Phragmites communis*, *Thamnochortus insignis*, *Arundo Donax*, *Cyperus textilis*, *Typha* spp., *Eleocharis limosa*, *E. palustris*, *Juncus* spp., *Blechnum capense*, *Pteridium aquilinum*, *Agave americana*, *Phoenix dactylifera*, *Proteaceae* in fruit, *Nerium oleander*, *Noltia africana*, *Nicotiana glauca*, *Populus canescens*, *Acacia decurrens*, *A. cyclopis*, *A. saligna*, *Brachylaena neriifolia*, *Schotia speciosa*, etc., all in the form of complete plants, branches, or rhizomes; fruits of *Melanthus comosus*, *Rumex* spp., *Quercus robur*, *Xanthium* spp. (mostly *X. pungens*), *Brabeium stellatifolium*, etc.; corms of *Iridaceae* and bulbs; and leaves of *Opuntia maxima* (which produced lateral buds and established themselves on the coast). Two hundred small seeds of various kinds were counted in a space twelve inches square. The following put forth shoots or germinated temporarily in the drift:—*Cyperus textilis*, *Prionium serratum*, *Typha australis*, *Aloe arborescens*, *Phragmites communis*, and several kinds of grain.

Higher up the beach on a place previously completely bare a number of plants appeared:—*Cotula coronopifolia*, *Rhaphanus raphanistrum*, *Chenopodium murale*, *Rumex ecklonianus*, *Stenotaphrum secundatum*, *Pelargonium grossularioides*, *Malva rotundifolia*, *Osteospermum moniliferum*, *Hydrocotyle asiatica*, *Emex australis*, *Oligocarpus calendulaeaeus*, *Lolium temulentum*, *Cotula filifolia*, *Sium Thunbergii*, *Senecio Burchellii*, *S. elegans*, *S. rosmarinifolius*, *Oxalis caprina*, *O. cernua*, *Silene gallica*, *Anagallis arvensis*, *Crassula glomerata*, *Cryophytum Aitoni*, *C. crystallinum*, *Juncus maritimus*, *Berkheya rigida*, *Polygonum acuminatum* and *Polycarpum tetraphyllum*.

As most of these have non-buoyant seeds the latter may have been carried down on logs, debris, or while still attached to the parent plant; but in the shallower places they may have been swept by the force of the current along the bottom of the river or estuary.

On 13 December 1929 when I revisited the spot the little community had been destroyed by the heaping-up of sand.

#### *East London Coast.*

I collected here the following drift-seeds of local origin:—*Ipomoea Pes-caprae*, *Calonyction aculeatum*, *Canavalia obtusifolia*, *Colea lachryma-Jobii*, *Mimusops obovata*, *Vigna luteola*, *Hibiscus tiliaceus*, *Calodendron capense*, *Scaevola Plumieri*, *Podocarpus falcata*, *Sideroxylon inerme*; bulbillae of *Acidanthera brevicollis*, tubers of *Rhoicissus Thunbergii* and of a species of *Asparagus*. Fruits of *Cryptocarya latifolia* found here probably came from the coast-belt of Pondoland or Natal, and seeds of *Thespesia populnea* from

Zululand or a foreign source. The alien drift-seeds are the same as those found on the Riversdale coast, but I gained the impression that these, both as regards quantity and variety, were less than at the last-named station and other localities to the westward.

### *Pondoland Coast.*

The writer found the following fruits and seeds at Port St. Johns:—*Cryptocarya latifolia* from the neighbouring forest were those most common. Many seeds of *Ipomoea Pes-caprae* seem here to lose their hairs before reaching the drift, and others show abortive germination while still lying under the parent plants. Other seeds and fruits belonged to *Encephalartos* sp., *Millettia caffra*, *Calodendron capense*, *Mimusops obovata*, *Sideroxylon inerme*, *Ricinus communis*, *Scaevola Plumieri*, *Canavalia obtusifolia*, *Barringtonia racemosa* (dead), a hypocotyl of *Bruguiera gymnorhiza* from the estuary of the Umzimvubu, *Hibiscus tiliaceus*, *Pachystigma* sp. (dead, and the same species as in the Riversdale drift), and the gourds of a *Lagenaria*. After a careful search lasting two days only two alien seeds, namely those of *Mucuna gigantea* and *Intsia bijuga*, were discovered. It seemed to me that the current which brought a large proportion of alien seeds to parts of the coast further to the west followed the course of bottle-drift No. 11 of Schott's series, and that the paucity of alien seeds on the Pondoland Coast was due to its lying in too low a latitude to derive full benefit from the supply of seeds conveyed by that route. In other words, Pondoland is dependent for alien seeds more on the current route between Madagascar and Moçambique.

### *Natal and Zululand Coast.*

Drift seeds were collected for me by Miss H. J. Muir at Isipingo and by Dr. H. G. Schweickerdt near Port Shepstone, viz:—*Barringtonia racemosa*, *Canavalia obtusifolia*, *C. bonariensis*, *Scaevola Plumieri*, *Ipomoea Pes-caprae*, *Hyphaene crinita*, *Ricinus communis*, *Cryptocarya latifolia*, *Pachystigma* sp., *Caesalpinia crista*, and *Entada gigas*. All these may have originated within South African limits, and there were no alien seeds found.

Seedlings of the three local mangroves, and seeds of *Coir*, *Entada*, *Caesalpinia* and other species were found by the writer near Durban.

A comprehensive collection is that sent me by Miss H. J. Muir and Miss C. Ladlau from Umhlali, 37 miles north of Durban, which included, in addition to all those above, *Mucuna gigantea*, *Intsia bijuga*, *Dioclea reflexa*, *Anacardium occidentale*, *Colonyction Bonanox*, *Mangifera indica*, *Acacia Benthami*, and *Ipomoea* sp. Alien seeds were scarce.

R. D. Aitken and G. W. Gale saw near Emalangeni drift-fruits of *Barringtonia racemosa* and *Entada gigas* (*Bot. Surv. Mem.*, II. 13). From St. Lucia Bay Dr. Pole-Evans sent me drift-seeds of *Canavalia obtusifolia*. All these may originate locally.

## THE BEACH AND RIVER-DRIFT AT LOURENÇO MARQUES.

(a) *On the shores of the Bahia de Lourenço Marques.*

The localities specially examined were at and beyond Polana east of the town, which is on the west side of the Bay, and also from Cateembe onwards in the direction of the sea on the opposite shore. The seed-drift was more tropical and more abundant than at any other station in southern Africa yet considered. The large angular seeds and quadrants of pericarps of *Nylocarpus granatum* and *N. moluccensis* constituted at least 90 per cent. of the seed-drift, very many being dead and in a state of arrested germination. Judging from the thick and massive sections of the pericarp some of the fruits must have been six inches in diameter. Many of the seeds had been hollowed out by borers, and as they lay in the sand contained grubs like those found in decayed wood. Fresh and germinable specimens, which may have travelled a shorter distance, or been lying for less time on the beach, were on the other hand very numerous. The natives here recognize that these seeds have been brought by the sea. Next in order of frequency were fruits of *Barringtonia racemosa*, some perfect, some riddled by borers, others with the swimming layer exposed. The third place was taken by hypocotyls of *Ceriops tagal*, nearly all fresh-looking, many partly buried in sand in places where they could not establish themselves. Other seeds belonged to *Manifera indica*, *Arachis hypogaea*, *Anacardium occidentale*, and *Myristica* (nutmegs), which are all articles of food or export. One or two pecan nuts (*Carya* sp.) were also found. Seeds of *Entada gigas* and *Caesalpinia crista* were not abundant in the drift, although multitudes of the latter lay behind the foremost sandy ridge. The other principal drift constituents were:—"stones" of *Scaevola Plumieri*; seeds of *Sophora tomentosa*, *Canavalia obtusifolia* and *Ipomoea Pes-caprac*; pods of *Decaris trifoliata* and *Dialium Schlechteri*; an occasional capsule of *Dodonaea viscosa*; drupes of *Terminalia catappa* (cultivated); coco-nuts; and fruits of *Trapa bispinosa* (cultivated). Hypocotyls of *Rhizophora mucronata* were not plentiful, *Bruguiera gymnorhiza* was represented by the calyces, and *Avicennia marina* by the empty fruit-coverings. *Dioclea reflexa* was rare, and *Azelia bijuga* was not found. The fruits of *Pretraca zanguebarica*, *Kigelia pinnata* and *Conopharyngia elegans* are present accidentally, and are not current-dispersed. The drift-seeds found at Inyaka Island, which is twenty-two miles across the Bay, are much the same as those recorded for the latter station.

(b) *The River Drift at Vila Luisa.*

Here in the drift of the Inkomati River the writer found seeds of the same species of *Decaris*, *Trapa*, *Dialium*, *Entada*, *Caesalpinia* and *Sophora*. Fruits and seeds, probably of *Nylocarpus granatum*, are fairly numerous. Many seeds of *Entada* are possibly carried by the river directly out to sea and were not very plentiful in the drift, although the plant grows at no great distance. But at the time of the visit the pods in the adjoining forest were still green. Numerous fruits of *Barringtonia racemosa* were germinating in the drift, while others had rooted in the sand just above it producing young plants which were from six to eighteen inches high. It was impossible to

walk many yards along the shore without seeing seeds of *Mucuna gigantea*. Fruits of *Scaevola Plumieri* and seeds of *Ipomoea Pes-caprae* were not found here, but seeds and fruits of *Jatropha Curcas* were present from shrubs overhanging the river banks.

*Inhambane, Portuguese East Africa.*

A collection of drift-seeds kindly sent me by Dr. C. J. Stauffacher contained the following:—*Heritiera littoralis*, *Sonneratia caseolaris* (fruits and seeds germinating in drift), *Casuarina equisetifolia*, *Xylocarpus moluccensis*, *Mucuna gigantea*, *Hyphaene crinita* (fruits buoyant but not sea-dispersed), *Aleurites triloba* (of local origin and not yet, as is more usual, dead), *Terminalia catappa*, *Jatropha Curcas*, and the same species found at Lourenço Marques of *Entada*, *Caesalpinia*, *Bruguiera*, *Ceriops*, *Rhizophora*, *Avicennia*, *Scaevola*, *Barringtonia* and *Ipomoea*. Seeds of *Telfairia pedata* reach the shore from inland by river agency, but are not sea-dispersed.

*Beira, Portuguese East Africa.*

A collection of drift-seeds made by my daughter, Miss Hortense J. Muir, in July, 1936, consisted mainly of fruits or seeds of: *Heritiera littoralis*, *Xylocarpus moluccensis*, *Ceriops tagal*, *Sonneratia caseolaris*, *Lumnitzera racemosa*, *Rhizophora mucronata*, *Bruguiera gymnorrhiza*, *Derris trifoliata*, *Sophora tomentosa*, *Caesalpinia crista*, *Canavalia obtusifolia*, *Mucuna gigantea*, *Hibiscus tiliaceus*, *Thespesia populnea*, *Barringtonia racemosa*, *Anacardium occidentale*, *Mimusops caffra*, *Scaevola Plumieri*, *Pachystigma (Vangueria) sp.*, *Vigna sp. (? V. marina)*, *Ipomoea Pes-caprae*, and *Elaeis guineensis*; etc. I was much interested in the kernel of the last named, which is identical with others collected by myself in the drift of West Africa.

THE MALAYAN AND EASTERN BEACH-DRIFT.

For purposes of comparison with the South and East African beach-drift, an account of that found at some stations on the eastern margin of the Indian Ocean is both interesting and instructive.

1. *Near Batavia.*

Dr. Z. Kamerling found the following seeds and fruits in the neighbourhood of Batavia:—*Cerbera Odollam*, *Nipa frutescens* Thunb., *Pangium edule*, *Carapa moluccensis*, *Inocarpus edulis*, *Caesalpinia Bonducella*, *C. nuga*, *Heritiera littoralis*, *Derris uliginosa*, *Pongamia glabra*, *Calophyllum inophyllum*, *Cordia subcordata*, *Gluta Renghas*, *Terminalia Catappa*, *Barringtonia racemosa* and *Aleurites triloba*. The antiquated nomenclature has intentionally been left unaltered, but it is clear what plants are indicated. (*Teysmannia*, XXII, 1911.)

2. *South Coast of Java.*

Schimper (*Ind.-mal. Strandflora*, 1891, 160-2) recorded:—*Barringtonia speciosa*, *B. excelsa*, *Heritiera littoralis*, *Cerbera Odollam*, *Cocos nucifera*, *Nipa fruticans*, *Canarium sp.*, *Terminalia*

*Katappa*, *Carapa obovata*, *Pangium edule*, *Calophyllum inophyllum*, *Pandanus* spp., *Pongamia glabra*, *Cynometra cauliflora*, *Caesalpinia Bonducella*, *Dioclea* sp., *Erythrina* spp., *Bruguiera* sp., *Lumnitzera racemosa* or *L. coccinea*, *Scyphiphora*, and *Ipomoea Pes-caprae*.

### 3. Kaw Tao.

Dr. A. Kerr, with whom I had many conversations at Kew, gives the following from Kaw Tao, an island in the Gulf of Siam. (*J. Siam Soc., Nat. Hist. Supp.*, VIII, 2, 1930):—*Calophyllum inophyllum*, *Heritiera littoralis*, *Canavalia maritima* (*C. obtusifolia*), *Sophora tomentosa*, *Caesalpinia crista*, *C. Nuga*, *Terminalia catappa*, *Barringtonia asiatica*, *Guetarda speciosa*, *Scaevola frutescens*, *Cerbera lactaria* Ham. (the fruit smaller than that of *C. Manghas* L.), *Ipomoea Pes-caprae*, *Calonyction album* House (*C. grandiflorum* Choisy), *Clododendron inerme*, *Hernandia ovigera* L., *Casuarina equisetifolia*, *Cocos nucifera*, *Thuarea involuta* R. & S., *Xylocarpus obovatus*, *Mucuna gigantea*, *Dalbergia candenatensis*, *Derris trifoliata* Lour. (*D. uliginosa* Benth.), *Bruguiera* sp., *Cerriops* sp. (probably *C. tagal*), *Cerbera Manghas*, *Sapium indicum*, *Nypa fruticans* Wurm., *Dillenia indica*, *Durio zibethinus*, *Neesia* sp., *Grewia paniculata*, *Canarium* sp., *Mangifera* sp., *Spondias acuminata*, *Dioclea reflexa*, *Erythrina fusca*, *Derris elegans* (?), *Entada* spp., *Lagerstroemia Flos-Reginae*, *Citrullus vulgaris*, *Myristica* (?) sp., *Ricinus communis*, *Trewia nudiflora*, and several others.

### 4. Keeling Islands.

The following partial list of drift-seeds has been compiled from others given by Darwin (*Chall.* IV, 113-5); Forbes (*A Naturalist's Wanderings in the East.* Arch., 1885); and Guppy (*J. Vict. Inst.*, XXIV, 1890):—*Hibiscus tiliaceus*, *Triumfetta repens* (Blume) Merr. & Rolfe, *Pemphis acidula*, *Acacia farnesiana*, *Caesalpinia crista*, *Guetarda speciosa*, *Ochrosia parviflora*, *Scaevola frutescens*, *Cordia subcordata*, *Tournefortia argentea*, *Calophyllum inophyllum*, *Barringtonia asiatica*, *Ipomoea grandiflora*, *I. Pes-caprae*, *I. gracilis* R. Br., *Hernandia peltata*, *Pandanus* sp., *Thespesia populnea*, *Suriana maritima*, *Morinda citrifolia*, *Cocos nucifera* and *Aleurites triloba*. Some of these are also dispersed by man and other agencies. Part of this drift is foreign, but probably most of it local, in origin.

But Guppy found drift-seeds of species which did not grow in the islands:—*Pangium edule*, *Heritiera littoralis*, *Xylocarpus moluccensis*, *Erythrina variegata*, *Mucuna macrocarpa*, *M. gigantea*, *M. spp.* (?) 3 or 4, *Dioclea reflexa*, *Cynometra cauliflora*, *Entada scandens* Benth. (*E. phaseoloides* Merr.), *Lumnitzera littorea* Voigt, *Verbena manghas*, *Excoecaria indica* (*Sapium indicum*), *Casuarina equisetifolia*, *Cycas circinalis*, *Nypa fruticans*, etc. The drift-seeds are still preserved at Kew in the Guppy collection.

### Affinities of the South African Seed-drift.

The South African seed-drift varies in nature and composition on different portions of the coast, and has affinities not only with the temperate but also with the tropical type. Most of the coast line lies indirectly or directly within the sphere of influence of the great current-system of the Indian Ocean.



As is shown by the synopsis of strand plants in a subsequent chapter, the littoral species in South Africa, including those with buoyant sea-borne seeds, have in many cases areas of distribution which include Indo-malaya and also the Pacific. The main direction of oceanic seed-dispersal has been from east to west. Important affinities of the South African seed-drift and littoral flora are thus not only deducible but evident. This is borne out by the analysis of the drift found on our shores. As regards the East African littoral vegetation and seed-drift the affinities with those of the East are still more marked.

On the west coast of South Africa conditions are peculiar. Opposite the desert area seed-drift of local origin hardly exists, and may be compared with that of the coast of Northern Chile, which is likewise opposite a desert area. Alien drift is also poorly represented, as the Benguela Current appears to distribute very few seeds, although some are brought by the Agulhas Current and are found on the coast mostly between the southern part of Namaqualand and Cape Point.

The coast from Cape Agulhas to the Kei River mouth reveals a local seed-drift, which in amount and variety is perhaps richer than that of many other temperate coasts of the world. Absolutely, however, it is not rich and the number of species concerned in its production is not great: this in the small Riversdale section is clear. These again are temperate characteristics. The variety of the alien seed-drift of South African temperate latitudes such as those of Riversdale is striking, but when the current connections are remembered it is not surprising.

From the Kei River onwards the native South African seed-drift becomes more tropical in type. A puzzling feature is that certain alien seeds, which can only come from Madagascar, become less numerous. I can only suggest that the bulk of these seeds follow the course of Bottle II of Schott's series, and strike our coasts mostly somewhere about here and to the westward of it. If the composition of the alien seed-drift afford an indication, it may well be the case that the drift brought down the Mozambique Channel from the north is added to that which follows the S. W. route, taken by drift-bottle No. 11, chiefly in this same vicinity.

In East Africa the seed-drift, both local and foreign, is entirely tropical in type.

The greater abundance on tropic beaches of stranded seeds derived from the neighbouring beach-vegetation is also a feature in Mozambique and in Madagascar.

The larger size of constituents of the tropical seed-drift is considered to be more characteristic of the Old than of the New World. The East African and part of the South African drift, in this respect, approaches the East Indian type.

The generalization that effective oceanic seed-dispersal is mainly restricted to warm countries, and that there is on the whole little effective dispersal by this means in temperate latitudes, has been maintained by many observers. It seems to be corroborated in South Africa. But even in the tropics it seems to be slow and often for-

tuitous. Guppy, for example, found, at the time of his visit to the Keelings, that only about a dozen out of from 50 to 60 species of drift-seeds collected by him there belonged to species which had established themselves on the islands (*J. Vict. Inst.*, 1890, 277).

Only nine species of alien seeds, all from the West Indies, are found on beaches of the British Isles, and six on those of the Azores. These numbers are far exceeded by that for the Riversdale coast alone.

A striking feature, therefore, of the South African seed-drift, even in our temperate latitudes on the south coast, is the large number of seeds which have been transported from the tropics over great distances, owing to a specially favourable geographical relationship between the courses of the currents and the position of the sub-continent.

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### CHAPTER III.

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#### MISCELLANEOUS SOUTH AFRICAN STRAND AND OTHER PLANTS.

##### *Historical Note.*

From the end of the fifteenth century onwards the shores of South Africa were visited by many navigators and travellers.

Even as late as 1752 the coast of Riversdale is marked on C. D. Wentzel's map "onbekende strand"—i.e. unknown coast—and up to within modern times this area has been difficult of access from the landward side owing to the lack of roads across the immense deposits of blown sand.

Floating masses of *Ecklonia buccinalis* were regarded by the early Portuguese sailors as a sign of the proximity of the land, and some typically littoral plants are mentioned in early literature. C. P. Thunberg, who was in South Africa from 1772-75, recorded (*Travels* I, 249, 252) that *Myrica cordifolia* was a source of wax and *Salicornia fruticosa* (not of Linn. but *Arthrocnemum litorum* Moss) used as a salad. Of *Osteocephalum niveum* (*Cryptostemma niveum* Nichols) he wrote, "*crescit in littore maris*"; and of *Convolvulus radicans* (*Ipomoea carnea* R. Br.), that it grew on our coasts, but gave no locality. The same writer stated of *Scaevola Lobelia* (syn. *S. Plumieri* Vahl) "*crescit in Musselbay ad littus maris*"—a place where it is still abundant.

Old maps throw light on the former position and nature of some of our strand habitats and enable us to judge of later changes. John Barrow travelled here during 1797-98, and published charts of Table, False, Plettenberg, and Algoa Bays as well as of the Knysna estuary. The last of these shows islands affording at that time pasturage, areas which were bare at low water, shoals, channels, and soundings.

F. Valentijn (*Besch. Oud en Nieuw O. I.*, 1726. IV 25) shows in a map an area on the coast of Java, which in the seventeenth century was submerged but is now silted up. A modern example is Sandwich Harbour on our west coast where the progress of sand-spit formation may be studied by comparison of charts made at different periods.

The chief South African plants, producing seeds found in the drift—not necessarily proof of sea-dispersal—are as follows:—

## CYCADACEAE.

*Encephalartos* sp.

*E. Altensteinii* is the usual species. It is not a strand-plant and the seeds are dead when found at Riversdale and elsewhere in the drift.

## TACCACEAE.

*Podocarpus elongata* L' Hérít.

The "stones" are plentiful but non-viable in the drift-state at Riversdale and East London. Of fresh well-dried germinable fruits only 5 per cent. still floated in fresh water after seventy-two hours, but when previously stripped of the soft parts they sank immediately. Birds, bats (*Rousettus leachi*), and the wild pig (*Potamochoerus choeropotamus*), but not the sea, are the effective agents in dispersal. It is not a strand-tree.

## GRAMINEAE.

*Coix lachryma-Jobii* L.

This is cultivated by Indians near river-banks in Natal and the seeds thus eventually reach the beach-drift. Of 16 fresh seeds tested at Riversdale 6 floated in fresh water but sank after two to six days. This result agrees with Guppy's and they have no real capacity for water-dispersal. They are used in the south-western districts of the Cape Province as necklaces.

*Sporobolus virginicus* and *Spartina stricta* may be to some extent dispersed by the sea by means of broken-off pieces of the plants, which may sometimes be seen in the drift or lying detached near the parent clumps.

## CYPERACEAE.

*Mariscus dregcanus* Kunth is usually considered to be sea-dispersed. *Cyperus maritimus* Poir., since it occurs not only on the mainland but on distant islands, may also be so. *C. natalensis* is found far inland as well as on the coast, but may be partly sea-dispersed by detached portions of the rhizome.

## LILIACEAE.

*Anthericum revolutum* L.

The dry flowering stems bearing capsules with seeds are often blown along the beach like a "tumble-weed," but the seeds are non-buoyant. The writer has found the capsules in the burrows of dune-rats at Riversdale.

## CASUARINACEAE.

*Casuarina equisetifolia* L.

The writer has picked up the cones on the beaches of Nigeria, Angola, and Moçambique, but mostly near the parent trees, the species being introduced and cultivated. Dispersal is brought about partly by the sea, partly by the wind, and possibly by floating logs, which may occasionally carry seeds.

## POLYGONACEAE.

*Polygonum maritimum* L.

Fruits collected at Lambert's Bay showed no buoyancy, but they may, according to Guppy, float for three or four days if the perianth is not removed. (*N.P.* 11, 543). Portions of the plant floated in sea-water for a slightly longer period.

## CHENOPODIACEAE.

*Salsola Kali* L.

The writer has met with this plant at a number of South African coast stations and also far inland. Dry fruits from the Riversdale coast, while still in the perianth, floated for 5 to 7 days, which is also true of portions of the plant. It may also be dispersed by ballast, flood-waters of rivers, farming operations, wind, and introduction at the ports in forage, etc.

*Arthrocnemum* and *Salicornia*.

Some species of these genera are dispersed by floating seedlings and detached seeded joints, which appear in the drift. *Arthrocnemum indicum* is found in the mangrove near Lourenço Marques. *A. natalense* occurs all round our coast from South West Africa to Natal.

## AIZOACEAE.

*Disphyma crassifolium* N. E. Br.

In addition to dispersal by seed, pieces of the stem are often broken off by the waves and cast up elsewhere in the beach-drift, where they root easily. Branches placed in water at Riversdale floated and after five days were planted, eventually bearing flowers, but the seeds were found to be non-buoyant.

*Sesuvium portulacastrum* L.

Seeds collected by the writer in Portuguese East Africa had no buoyancy, but pieces of the stems may be drifted away by the sea. It would be possible for floating logs and pumice to play a part, as well as the feet of birds.

*Tetragonia decumbens* Mill.

This is widely distributed on the shore and dunes, and in the coastal bush, has winged fruits, and is chiefly wind-dispersed.

## LAURACEAE.

*Cassytha filiformis* L.

This string-like parasite is restricted to the warmer coast regions of South Africa. At Lourenço Marques it twines around *Ipomoea Pes-caprac*, *Scaevola Plumieri*, *Tephrosia canescens*, and plants in the psammophilous scrub. The fruits in the Pacific have an effective buoyancy lasting several months. (*P.S. & C.* 192). Fruits collected by the writer at Lourenço Marques and thoroughly dried for three months subsequently, gave the following results:—10 per cent. sank immediately, 58 per cent. after the 5th day, but only 18 per cent. were afloat after the 8th day. Tests at Buitenzorg, Java, showed that they floated for little more than a week. (*C.A. Backer, l.c.* 92).

Fruits of *C. ciliolata* from the Riversdale coast-dunes were also tested, 145 out of 156 sinking at once.

*Cryptocarya latifolia* Sond.

The dead crustaceous shells of an unknown fruit were found in 1929 to be common in the Riversdale drift, and in Pondoland to be the most abundant seed on the sea-shore. When the writer took samples with him on a visit to the latter country in 1931, they were recognized by the Pondos as the fruits of "Umtungwa," or *Cryptocarya latifolia*, a tree common in the neighbouring coastal forests. In the *Flora Capensis* they are stated to be unknown, but Sim mentions that they are used by the young natives as clothing and are eaten by baboons and blue-buck. They are nearly globose, or rarely oblong-globose, about an inch in diameter, and when the light to dark-brown exocarp is removed a shell is exposed which after long drying tends to split into five segments. They bear a superficial resemblance to those of *Calophyllum inophyllum*. The fruits in the drift are in the writer's experience non-viable, the sea not being concerned in dispersal. When some were placed at Riversdale on a gentle rocky slope they were moved away by a downpour of rain for distances ranging from two to twelve feet. Some of the smaller drift-fruits in the writer's collection may belong to *C. Woodii*, which has a distribution extending from King Williams Town to Natal. Miss Forbes has reported *C. latifolia* as growing on Salisbury Island in Durban Harbour.

LEGUMINOSAE.

*Vigna marina* (Burm.) Merrill.

This plant, which has sea-dispersed seeds, has been collected in South Africa apparently only near the Umgeni River mouth and between the Umtentu and Umkomaas rivers. The seeds are 6 mm. long, but have not been recorded from the South African drift. The above name replaces *V. lutea* A Gray and *V. retusa* Walp.

*V. luteola* (Jacq.) Benth.

While this is regarded by some botanists as synonymous with the preceding species, it is by W. G. Craib in his recent *Flora of Siam*, and many others still kept distinct. It is common from Uitenhage to Natal. The seeds, about 5 mm. long, are difficult to find and probably often overlooked; but the writer has collected eight of them from the Riversdale drift. They are sea-dispersed.

*Canavalia obtusifolia* DC. (*C. maritima* Thou.)

The habitat for this plant which is nearest the Riversdale coast is about 400 miles distant in the neighbourhood of East London. About thirty seeds, and a growing seedling from a stranded seed, have been found in the Riversdale drift. A drift-seed, previously notched, germinated in the writer's garden in the open air, attaining a height of eight feet in ten months after which it was killed by frost. An unnotched seed which was sown was dug up unaltered fifteen months later.

Of 15 fresh Natal seeds tested at Riversdale in salt water only three were afloat after 75 days, and of 20 fresh seeds brought by the writer from Port St. Johns eight still floated after 61 days. He

tested 100 fresh seeds at Lourenço Marques of which 90 were initially buoyant. Later at Riversdale some of these commenced to germinate while floating indoors during summer in fresh water.

In Fiji 10 per cent. of fresh seeds were afloat in sea water after three months; in Jamaica 40 per cent. after one month. This fickleness of behaviour is ascribed by Guppy to only 70 per cent. of the seeds being impervious to water (*P. S. & C.*, 190): the proportion of impermeable seeds varies considerably, being sometimes more and sometimes less in different collections.

*Canavalia bonariensis* Lindl.

C. V. Piper (*Contrib. from U. S. Nat. Herb.* XX, p. 555), states that this plant is "without scarcely a doubt introduced into South Africa"; but he does not say by what means. Miss H. Forbes (*l.c.*, 306) reports this plant and *C. obtusifolia* as growing on Salisbury Island, and the shores of Durban Bay, and as being water-borne. There is no reference to its dispersal in the leading text-books. Twenty-nine drift-seeds, which were compared with fresh seeds from this site, have been recovered by the writer from the Riversdale drift. They are elliptical or somewhat rectangular; medium to dark brown, usually but not invariably unspotted; the elliptical form 15-19 mm. long, 12-15 mm. broad, by 6·5-8·5 mm. thick; weight 11-22 grains; the more rectangular form 16-18 × 12-15 × 10-12 mm.; weight 19-24 grains. The raphe is strangely like that of *Mucuna*, but only involves one-half of the circumference. All were sound and most floated at Riversdale in fresh, in sea, and in 3·5 per cent. salt water. It was found that fresh seeds remained afloat after three months. In all respects seeds conform on dissection to the characteristics of the genus. The distance from Pondoland where it also occurs to Riversdale is at least 500 miles by sea, and the route followed by the seed may be longer. It may also have arrived in ballast taken from a S. American beach.

*Acacia farnesiana* Willd.

The pods of this species are indehiscent and are able to float for a month in sea-water, but the seeds themselves are non-buoyant. As it is now being cultivated on the coast of South Africa we may later find the pods in the drift.

Seeds of *Acacia saligna* and of *A. karroo* appear in the drift of the Riversdale coast in the dung of stock which drink at the fountains issuing from the upper beaches.

Pods of *Acacia Giraffae* are washed down to the beach at Walvis Bay by the Kuiseb river.

The seeds of an *Acacia*, indistinguishable from those of *A. Benthami* Rochbr., are common in the drift of Riversdale and of Umhlali, Natal. This species is not sea-dispersed, and fresh seeds sink.

Of these *Acacias* *A. farnesiana* is the only strand-species.

*Cassia fistula* L.

The legumes of this species are buoyant and pieces are occasionally picked up on the Riversdale coast, but the seeds have no separate buoyancy. It is cultivated in Natal and Madagascar.

*Arachis hypogaea* L.

Drift-fruits, probably from passing ships, are found even in remote parts of the coast and have therefore no significance. It is largely cultivated in Natal and Moçambique. Guppy refers to its occurrence on the beaches of South Devon. (*P. S. & C.* 29.)

I have not been able to find fresh fruits and seeds of *Tephrosia canescens* E. M.; and *Stylosanthes mucronata* Willd. non Miq. is not a strand-plant, although so included by Schimper.

## ZYGOPHYLLACEAE.

*Zygophyllum Morgsana* L.

Fresh seeds sink at once, but the fresh fruits float at Riversdale from four to six days, the survivors germinating afterwards in from two to five weeks. The capsules usually, but not invariably, dehisce on the shrub, and may, with the contained seeds, be blown about by the wind.

## RUTACEAE.

*Calodendron capense* Thunb.

This tree is common in ravines and elsewhere in the coast-scrub, often overhanging rivers so that the seeds in this way reach the beach-drift. They were found by Dr. G. Rattray and the writer in the drift at East London, and by the latter on the seashores of Pondoland and Riversdale. They are black, angled, half an inch across, and contained in a woody dehiscent capsule which falls into the streams and tidal creeks. Of 21 fresh seeds tested at Riversdale 20 were initially buoyant, 6 were still afloat on the 7th, 3 on the 10th, and only 1 on the 12th day. Such limited buoyancy may be of use inland; but the seeds are highly permeable, and this species is not sea-dispersed. They are eaten by antelopes.

## EUPHORBIACEAE.

Certain species of this family have seeds which appear accidentally in the beach-drift by way of the rivers, their buoyancy being limited, and the sea playing no part in dispersal.

*Ricinus communis* L.

The seeds, always or nearly always damaged or dead and stripped of the outer mottled layer, are common everywhere in our seed-drift, even in the desert zone at Walvis Bay. Of 60 fresh seeds tested by the writer only 4 floated after the 10th day but these survivors germinated when sown. Guppy found that they floated from 7-10 days. At Riversdale the cocci sank within 50 hours.

*Drypetes arguta* Hutch.

The empty cocci of this shrub, which occurs near the coast from Pondoland to Moçambique, are found, although rarely, in the Riversdale drift. Fresh fruits remained afloat in fresh water after the 11th day, but were already penetrated by water by the 3rd or 4th day.

*Spirostachys africanus* Sond. (*Excoecaria africana* Müll, Arg.)

Well dried cocci sank at Riversdale within four hours, but *E. Agallocha* Benth., a tree of coast swamps from India to the Pacific, has fruits which float for months and are sea-dispersed.

*Lachnostylis capensis* Turcz.

The cocci may appear in the South African drift but it is not a strand-shrub or sea-dispersed.

## SAPINDACEAE.

*Dodonaea viscosa* L.

Of local occurrence in the coast-scrub and on the dunes of Natal this shrub or small tree is more common northwards of that point. Seeds purchased from dealers in South Africa showed no buoyancy. It has been stated that the fruits are usually two-winged, but of 300 freshly gathered in the writer's garden at Riversdale 86 per cent. were three-winged. A few capsules were found in the drift in Moçambique, evidently blown into and subsequently washed up by the sea. There is a considerable variability in the buoyancy of the seeds according to whether they come from an inland or a coast station, so that the agency of currents alone cannot explain the distribution. Guppy (*P. S. & C.* 86) estimated the seeds to have an effective buoyancy of two months, and Schimper of from 10 to 60 days. In Hawaii only half the number of the seeds floated. (*N. P.* II, 339.)

*Cardiospermum Halicacabum* L.

Of 64 fresh seeds tested at Riversdale 38 sank at once and only 4 floated by the second day: of 50 fresh seeds still attached to the septum all floated initially, but only 2 on the third day. Ridley states, nevertheless, that it seems to be partly sea-dispersed, but as far as South Africa is concerned this is not corroborated by the above. It is not a true strand-species.

## RHAMNACEAE.

*Noltia africana* Reichb.

The seeds and fruits are abundant in the Riversdale beach-drift to which they are carried down by the rivers, but it is an inland stream-bank, not a seabeach, species. Its chief interest lies in the close resemblance of the seeds to those of *Colubrina asiatica*, a tropic sea-dispersed plant.

*Helinus ovata* E. Meyer.

This is a scandent woody climber among scrub along riversides in the Eastern Province, Transkei, Natal, Zambesia and Lower Guinea. The seeds, which are small, obovate, convex, black, shining, and with a slit at the narrow end, are common in the South African drift, but in that state not viable.

## MALVACEAE.

*Hibiscus tiliaceus* L.

The writer found 47 of these small seeds, which are well known to be sea-dispersed, in the Riversdale drift, the nearest locality for the tree being 400 miles eastwards. The seeds can cross the widest stretches of ocean and remain germinable. He found sound seeds plentiful on the trees on the estuaries of the coasts of East London, Pondoland, and Moçambique, but Guppy states (*P. S. & C.*, 217) that he frequently had difficulty in obtaining sound seeds.



*H. diversifolius* Jacq.

Fresh seeds of this plant are readily distinguishable from those of *H. tiliaceus*, but it is difficult to be certain about them when the seeds of both kinds are polished and smooth in the drift state. Owing to the occurrence of this suffrutex in coastal swamps the seeds may occasionally reach the drift but are probably not sea-dispersed: it is, moreover, also found inland. As a practical point almost all drift-seeds of *Hibiscus* belong to *H. tiliaceus*. Of 200 fresh seeds from the Cape Peninsula kindly supplied by Professor R. H. Compton, 7 per cent. sank at once, but 65 per cent. were still afloat after 42 days, when the test was terminated. Some of the survivors were then planted out and after 29 days produced plants which flowered freely from February to May. Guppy found that they floated for months, his material being from Fiji (*N.P.* II, 529).

*Thespesia populnea* Sol.

Eight seeds, which agree exactly with fresh material collected by the writer from the trees in Moçambique, have been found in the Riversdale drift and appear sound.

## THYMELAEACEAE.

*Passerina rigida* Wikst.

The black crustaceous fruits of this strand and dune shrub are non-buoyant; but while still contained in their orange sub-succulent investment can float for two or three days in a quiet room, probably for less in the waves. Only eight out of one hundred were afloat after the end of the third day. They form an orange-coloured line in the drift, but are not dispersed by the sea. Wind and birds seem to be concerned in dispersal.

## LÆCYTHIDACEAE.

*Barringtonia racemosa* Roxb.

Ten drift-fruits, all as is usual without the exocarp and several fragmentary, were during the years 1932-35 found on the Riversdale coast; but several were sound and apparently germinable. Probably a number were overlooked. Some may have come from South African sources and others from Madagascar. They have suffered considerably from borers and wave action by the time they arrive.

## RHIZOPHORACEAE.

*Rhizophora mucronata* Lamk.

The writer's observations were made on material collected at Lourenço Marques. The fruit-cases remain on the tree after the seedlings are detached. The fruits are about  $1\frac{1}{4}$  inches long by hardly 1 inch in diameter; the hypocotyls are  $8\frac{1}{4}$  to  $13\frac{1}{4}$  inches long by about  $\frac{1}{2}$  inch at the thickest part below, which is situated at roughly  $\frac{2}{3}$  to  $\frac{3}{4}$  of the distance down. Similar measurements made in the Federated Malay States are according to J. G. Watson (*Mangrove Forests in the Malay Peninsula*, 1928):—Fruit 2 inches long by 1 inch in diameter; hypocotyl up to 2 feet, and 1 inch in diameter.

As regards buoyancy the writer's experience is not extensive and his tests are, therefore, perhaps somewhat inconclusive. Of 100 fresh

hypocotyls collected in December (i.e. in summer) and tested for initial buoyancy in salt water of sp. gr. 1,026 to 1,027 at Riversdale, 49 per cent. floated more or less vertically with the plumule above the surface, and the remainder sank. Out of ten of these buoyant seedlings four were still afloat after 50 days when the experiment was terminated. At Lourenço Marques in June and July, with good material found lying on the mud, the results when it was placed in a creek along which the trees grew were initially much the same. Guppy, experimenting with Fijian material, found that with buoyant seedlings about 90 per cent. floated horizontally in sea-water and 70 per cent. vertically or steeply inclined in fresh water; also that three out of five seedlings were afloat and healthy after eighty-seven days' immersion in sea-water. (*N.P.* II, 459.)

Many hypocotyls were found at Delagoa Bay lying in the beach-drift or on, sometimes partly buried in, the sand of the open beach five or six miles distant from the mangrove forest. Some of these were in good condition but others were blackened and dead. In a number of instances they had put forth rootlets in the lower moister strata of the drift. This locality was, however, entirely unfavourable for the plantlets to gain a footing.

When the hypocotyls were tested for ability to withstand dessication during winter in a room at Riversdale, in which the temperature during the day was not allowed to fall below 60° F., black spots began to appear after five weeks which gradually coalesced as vitality diminished. Guppy on the other hand kept specimens alive in a room for nine weeks, after which they were planted and grew. (*l.c.* 461.)

*Bruguiera gymnorhiza* Lamk. (*B. conjugata* Merrill.)

The hypocotyls range in length from 4½ to 6 inches, the latter being also the limit given for those in the Malay States. Twenty of the largest fresh specimens were tested for buoyancy in June in a creek near the river at Lourenço Marques. They all floated initially and were carried away by the current seawards.

Of fresh material tested later at Riversdale in 3½ per cent. salt-water none sank initially, some floated horizontally, others obliquely, a few vertically, but always in the last two instances with the plumule emerging above the surface.

Hypocotyls were still afloat at Riversdale after the fiftieth day, when the test was abandoned; but Guppy mentions that one of his floated for 117 days and remained sound and healthy.

Hypocotyls of *Bruguiera* remained alive on a shelf in a room at Riversdale for nearly four months, by which time those of the *Rhizophora* were already dead; but another collection of *Bruguiera* showed black spots on the surface after five weeks.

The fruit-cases are detached and fall from the tree with the seedlings.

*Ceriops tagal* Robins. (*C. candolleana* Arn.)

During June and July at Lourenço Marques the trees were bearing flowers and mature hypocotyls simultaneously. The fruit-cases remain behind on the tree after detachment of the latter. The hypocotyls are from 8½ to 12¼ inches in length, dark green, rugose,

ridged, and verrucose, with an orange or red cotyledonary body  $\frac{1}{6}$  to  $\frac{2}{3}$  of an inch long. They were found lying in great numbers under the trees or sticking upright in the mud. Hundreds more could be seen floating horizontally down the creeks to the sea.

Of 100 freshly collected specimens tested for initial buoyancy, 91 per cent. floated horizontally, 7 per cent. at an angle, and only 2 per cent. sank. Specimens were still afloat after three months in  $3\frac{1}{2}$  per cent. salt solution at Riversdale.

They were also present in the beach-drift of the bay, or often exposed on bare sand far away from the forest, looking in many cases as fresh as if they had just fallen from the trees. A fruit (*Muir* 4795) with two hypocotyls is in the writer's collection.

Seedlings of *Ceriops* were about as resistant to desiccation as those of *Bruguiera gymnorhiza*.

It is evident that seedlings of the *Rhizophoraceae* collected at Lourenço Marques have considerable capacity for oceanic dispersal, and under favourable conditions may be transported by water for some distance. No hypocotyls of any of them, even in a dead condition, have yet been found on Riversdale beaches.

#### SAPOTACEAE.

*Sideroxylon inerme* L.

The "stones" are abundant in the drift all along the coast, but, like the fresh fruits, are non-buoyant. The tree may grow within a few yards of the sea. The fruits are eaten by birds, animals, and man.

*Mimusops obovata* Sond.

The oblong, polished, black seeds are present in the drift at East London and Port St. Johns, where the trees may overhang the sea. They possess no real buoyancy.

#### UMBELLIFERAE.

*Cnidium suffruticosum* C. & S.

The mericarps are common drift-objects, but float hardly longer than 48 hours. They are blown along the beach.

#### OLEACEAE.

*Olea capensis* L.

The stones of this dune and inland tree are common near springs on the beach, their presence being due to animals which void them there. Even after being dried for eighteen months they were found at Riversdale to sink instantly in fresh water.

#### CONVOLVULACEAE.

The seeds of at least a dozen species of this family appear in the South African drift. Cultivation experiments show that nearly all are viable and have led to the identification of a few. I have had eight species from germinated drift-seeds growing in the open air simultaneously, but with the exception of two or three they die with the advent of winter. At the Royal Botanic Gardens, Kew, all the

seeds sent by me germinated, but the results, even under glass were the same. It was thought that they should have been sown in spring instead of in summer. (*In litt.* 4.3.1935.)

A long investigation, combined with all the resources of a conservatory and skilled horticultural experience will be required before the problems are solved. It was, however, evident from the young plants that some are not of South African origin. The following are definitely known to occur in the Riversdale drift:—

*Ipomoea Pes-caprae* Roth.

This is the source of most of our drift seeds of this family. They may germinate in many cases on the sand below the parent plants, probably also in the sea when the temperature thereof is sufficiently high (a proceeding apt to lead to sinking of the seed), and they often do so after arrival at the end of a sea-journey. At Riversdale they produce seedlings and plants which last for a short season and die down, but the plant is not native to that district.

*Calystegia Soldanella* R.Br.

There is a patch of this plant on the Riversdale coast, which I have had under observation for some years. (*K.B.* I. 1934.) Material of the flowers, fruit, and branches was determined at Kew. It is a current-dispersed species of the temperate regions of both hemispheres. This species and *Ipomoea Pes-caprae* may in Riversdale be said to overlap, which they were previously supposed to do only in eastern Australia. These areas of distribution meet, however, in the Kermadecs.

*Calonyction aculeatum* (L.) House [*C. Bona-nor* (L.) Boj.].

The seeds are common in the drift at Umhlali, Natal, and at East London where the plant is cultivated, but fourteen drift-seeds have been found on the coast of Riversdale in which district it is not a garden plant. Five drift-seeds from the latter station were sown and germinated, producing full-sized vines which flowered. It was determined for me at Kew by the courtesy of Sir A. W. Hill. They grew for some years and have long ago died, but for some seasons the seeds continued to come up in my garden. Of 70 fresh seeds all were initially buoyant, 2 sank on the 13th, 2 on the 16th, 1 on the 20th, 1 on the 100th, 5 on the 105th, and 59 were still afloat on the 149th day.

*Ipomoea cairica* (L.) Sweet (*I. palmata* Forsk.).

Seeds are abundant in the Riversdale drift, and some from that source produced strong plants in my garden, which were identified at Kew. The plant occurs near the coast in the Eastern Province, Natal, and northwards, often in forests near rivers which carry the seeds to the seashore. It is also found in other parts of the world. Seeds were found in the drift at Lourenço Marques.

*I. sp.*

The seeds of another *Ipomoea* common in the drift of Riversdale also germinate readily and produce flowers in cultivation. The plant was found by Dr. Schweickerdt at Kew to resemble closely *Ipomoea fimbriosepala* Choisy, but its identity is as yet not certain.

*I. carnosa* R.Br.

This species is recorded by Thunberg from South Africa but without locality. The seeds are well known to be dispersed by ocean currents. On a blank herbarium sheet at Kew Dr. N. E. Brown has written a note stating that Thunberg's specimen is identical with Welwitsch 6248! from Angola. On Welwitsch's sheet he has made another note: "*Convolvulus radicans* Thunb.! This specimen exactly matches the type specimen in Thunberg's Herbarium!!" It is marked *I. stolonifera* Gmel., which is regarded in the *Flora of Tropical Africa* as synonymous with *I. carnosa* R.Br., but there is no reference to this in the *Flora Capensis*. J. Hutchinson and J. H. Dalziel (*Flora of West Africa*) have also determined Welwitsch 6248! as *I. stolonifera* Gmel., with the remark, "common on the seashore: widely spread on the shores of warm countries". Welwitsch collected his plants in the district of Loanda, in between 8 and 9 degrees S. Lat., one to three miles from the sea on the banks of the River Lifune. Welwitsch 6249! is the same. I have seen no South African material.

*I. congesta* R.Br.

Certain collections from Durban in the Kew Herbarium, although at one time considered to belong to *I. purpurea* Roth and given as conspecific in the *Flora Capensis*, are now regarded as being *I. congesta* R.Br. and are kept distinct as proposed by Hallier (*Engl. Jahrb.* XVIII, 137). The indumentum on the leaves keeps it apart from typical *I. purpurea*.

*I. congesta* R.Br. is synonymous with *I. insularis* Steudel, and seeds quoted under the latter name have been regarded as irregularly buoyant. (*N.P.* II, 20,110.)

*I. hederacea* (L.) Jacq. is synonymous with *I. Nil* Roth. Seeds of this species when tested at Kew by the writer proved to be non-buoyant.

Some drift-seeds collected and sown at Riversdale produced small plants with foliage very like that of *Ipomoea congesta* R. Br.

## VERBENACEAE.

*Aricennia marina* (Forsk.) Vierh. var. *typica* Bakh.

This is the species which occurs in South Africa, East Africa, Seychelles, Mascarenes, and Arabia. It is not *A. officinalis* L. Those which occur in Java are the latter and *A. marina* (Forsk.) Vierh. var. *alba* Bakh.

Living buoyant seedlings are common in the drift especially near the estuaries, creeks, and backwaters, at Durban and Lourenço Marques; further away on the sandy beaches they are often represented only by the external coverings of the fruit. It is to the seedlings alone that transport by the sea applies, and I have found them rooting in the mud at a considerable distance from the trees from which they originated.

## SOLANACEAE.

*Datura Stramonium* L.

Fresh seeds do not float, but portions of the plant bearing seeds are transported by river-floods, and reach the drift on the coast where the empty seed cases are plentiful. I have also found them in the interior of hollow logs lying on the seashore.

## SCROPHULARIACEAE.

*Hebenstreitia cordata* L.

The cocci are common drift-objects, float under test conditions from 4 to 5 days, and have been found in the Riversdale drift and in the interior of logs where they were still viable. They are also dispersed by wind.

## RUBIACEAE.

*Pachystigma* sp.

The pyrenes of a species in the Riversdale and Pondoland drift belong either to *Pachystigma* (*Vangueria*) *latifolia* Sond. or *P. infausta*, which are not strand plants.

They are boat-shaped, laterally compressed, 19-20 mm. long, 13 mm. broad, 11 mm. thick, and always, in my own experience, dead. They are not effectually sea-dispersed.

## SCAEVOLA.

*Scaevola Plumieri* Vahl.

The fruits appear on the plants about the end of May, and by August both the fresh drupes and bared stones are numerous in the adjoining beach-drift. The writer examined 100 sound initially buoyant stones and found in every case that one of the two cells was empty; but Guppy (*P.S. & C.* 233) working with West Indian material found, although rarely, two-seeded stones. Buoyancy tests in salt water with fruits and stones from the Riversdale coast resulted as follows:—Of 100 fresh fruits all were initially buoyant, 29 had sunk by the 33rd day, 49 by the 63rd day, and 66 by the 100th day, leaving 34 still afloat. Most of the survivors had not been penetrated by water. The fruits which sank were divested of their pericarp and the stones replaced in water; some of these again floated but most sank instantly. The fleshy pericarp did not in most cases separate in the water of itself. Of fresh stones, all initially buoyant, 58 per cent. were still afloat after 160 days. Of dried stones seven months old collected under the shrubs, all initially buoyant, 93 per cent. were still afloat after 63 days, 61 per cent. after 100 days, and 47 per cent. after 169 days.

Comparing these results with Guppy's experiments with material from the Turks Islands, we find:—70 per cent. of the fruits remained afloat in sea-water after 63 days; and about 60 per cent. of the fresh stones and 80 per cent. of the old dried stones were afloat after six weeks: 66-67 per cent. of stones ten months old were still floating after eighteen weeks in sea-water, but half of the survivors had been penetrated by water (*l.c.* 234-5). The stones and exsiccated drupes, especially when assisted by the wind, roll down

the steeply sloping dunes, rain-wash playing a very small role in this absorbent sandy habitat. They are then swept away by the tides and are capable of wide oceanic transport. Whether on the Riversdale coast birds eat these hard yellow fruits, which do not as a rule become very soft and purplish-black, is difficult to decide. The writer has watched the birds *Amygdruis morio* and *Pycnonotus capensis* flying away from patches of the plant, but has not shot them and examined their crops. The birds may really have been feeding on the fruits of *Scaevola* associates, such as *Osyris abyssinica* and *Osteospermum moniliferum*.

Isolated seedlings of *Scavola Plumieri* from sea-borne seeds are common along the beach, even in places where the plant itself is absent from the background. The sea thus plays a part in local as well as wider oceanic dispersal.

Certain species of rats gnaw the stones open, leaving the pericarp and stone fragments in small heaps. *Arvicanthus pumilio*, the striped-rat, is a non-burrower, but *Gerbillus afer* excavates galleries. Although rather destroyers than dispersers of seeds, they also leave sound ones alongside the tracks which they make. The same gnawing of seeds of this plant was noted at Pointe-Noire in West Africa during a visit in September.

The writer thought formerly that branches dislodged by the sea might take root elsewhere. He found later that the stems and leaves stand sea-water badly, the latter rotting in three or four days. Plants also died which in the hot season were dug up and carefully planted in their original sites. Self-sown seeds germinate freely and the plant spreads also by vegetative growth.

Guppy, writing in 1917, mentions (*l.c.* 228) that the other sea-dispersed member of the genus, *S. frutescens* Krause (*S. Koenigii* Vahl), is not recorded from the East Coast of Africa. Although K. Krause (*Pflanzenr.* IV 1912) does not give it from there, the writer has seen collections thereof at Kew from Zanzibar, Pemba Island, and Mombasa.

#### COMPOSITAE.

##### *Osteospermum moniliferum* L.

The "stones" of the marginal drupes are common all round the coast in the drift, but 200 ripe fresh fruits all sank immediately, and even after prolonged drying showed no real buoyancy. They are voided by birds and many other animals which drink at springs on the seashore.

##### *Dimorphotheca fruticosa* Less.

Of 100 ripe marginal fruits 32 floated for two, 31 for three, and 14 were still afloat after four days, the last still remaining sound. They have thus no real buoyancy, being mainly wind-dispersed.

##### *Launaea bellidifolia* Cass. (*Microrhynchus sarmentosus* D.C.)

This plant is common on the sandy shores of the Indian Ocean, including such islands as the Aldabra Group. Professor Humbert (*Compositae of Madagascar*) regards *L. pinnatifida* Cass. merely as a variety. It is wind- and probably also partly sea-dispersed.

*Cryptostemma niveum* Nichols.

The seeds are wind-dispersed, but the plant also spreads vegetatively.

## BULBILS, TUBEROUS GROWTHS, ETC.

*Acidanthera brevicollis* Baker.

Dr. G. Rattray drew my attention to the bulbils of this iridaceous species, which grows on the seashore at East London and in Natal. Later I collected them on the plant itself. They were found by Dr. Rattray to float for three weeks. (*In litt.* 10.10.1929; 18.7.1930). They are spread over the beach by the waves.

*Asparagus* sp.

Pale tuber-like growths on the roots of a species of *Asparagus* growing at East London are common there in the beech-drift. Dr. Rattray wrote that they "certainly float some time". (*In litt.* 18.7.1930).

*Rhoicissus Thunbergii* Planch. (*Cissus Thunbergii* E. & Z.).

The underground tuberous growths of this river- and dune-scrub vine are striking objects in the Riversdale drift, and also occur at East London. They are two to four inches in diameter, more or less spherical, resembling a potato. They were placed in sea-water, and after remaining afloat after seventeen days were planted at Riversdale but eventually rotted in the soil. (*Ampelidaceae*).

A number of fresh seeds and fruits, mostly from inland sources, had to be examined in order to determine some of the drift-material which was unknown, and in some cases to ascertain whether they were present in the drift. Many of them are not even strand-plants. The following were found to have non-buoyant seeds:—*Abrus precatorius*, *Afzelia quanzensis*, *Cassia tomentosa*, *Virgilia capensis*, *Sutherlandia frutescens*, *Schotia speciosa*, *S. latifolia*, *S. brachypetala*, *Crotalaria capensis*, *Hypocalyptus obcordatus* (a few floated up to 36 hours, *Myrica cordifolia*, *Myoporum acuminatum*, *Viscum capense*, *Pterocelastrus tricuspidatus*, *Aitonia capensis*, *Melanthus comosus*, *M. major*, *Azima tetracantha*, *Olea laurifolia*, and nuts of *Cannamois cephalotes*. Of 27 fertile dried fruits of *Grielum tenuifolium* from the upper beach at Lamberts Bay all sank in 11 hours. Of 50 dried fruits of *Olinia cymosa* only one was afloat by the third day. Of 32 well dried sound fruits of *Elaeodendron croceum* DC. all floated initially in fresh water, 21 on the 2nd, and 4 on the 4th day: the previously stripped seeds sank at once.

Seeds or fruits of the following were found not to resemble any of those in my South African drift-collections:—*Dalbergia can-denatensis* (sea-dispersed in the East), *Tamarindus indica*, *Phaseolus lunatus*, *Leucaena glauca*, *Parkia filicoidea*, *Copaifera Mopane*, *Desmanthus virgatus*, *Trachylobium verrucosum*, *Albizzia Lebbeck*, *Sapium indicum*, *Pemphis acidula*, *Vitex trifolia*, *Sida cordifolia*, *S. acuta*, *S. rhombifolia*, *Manihot utilisissima*, and *Syzygium cordatum*. Several are drift constituents on the shores of the Indian Ocean in other countries.



## CHAPTER IV.

## THE CURRENT CONNECTIONS OF SOUTH AND EAST AFRICA.

The student of oceanic seed-dispersal does not require to go very deeply into the subject of currents, and uses the bottle-drifts recorded by hydrographers merely to illustrate the probable courses taken by the floating seeds. It is premised that these drifts indicate fairly the direction of the surface flow of currents.

The work of Dr. G. Schott (*Die Flaschenposten der Deutschen Seewarte* XX 1897) is a classic on which Guppy and others have based many of their conclusions. As far as the currents of the South Atlantic and the Indian Ocean are concerned, I have relied on the authority of this book, which was kindly lent to me by Dr. C. van Bonde; but as regards the South African coast I have made use of some of the work which has been so ably performed by Professor J. D. F. Gilchrist and his successor just mentioned.

The first attempt to make a hydrographic survey of a portion of the South African Coast is shown in a map dated 1660, or soon after the occupation of the country by the Dutch East India Company. The *African Pilot*, published in 1751, 1799, and 1856-84, gives wonderfully detailed accounts of the coast and the winds and currents affecting it.

The following summary includes one or two records which do not appear in previous literature on sea seed-dispersal.

(a) *On the West Coast.*

That South Africa may supply drift to Brazil is suggested by Schott's record of bottle-drift No. 6. This was launched on 7 Dec. 1880 in 29°24' S. Lat. and 33° E. Long. and found 11 Aug. 1882 at Alcobaco, Brazil, in 17°30' S. and 39°10' W., the distance being 4,120 sea-miles covered in 612 days, or a rate of 6·7 sea-miles per day (*l.c.* 19, 27, with maps). The route would be determined by the Agulhas, South African, and South Equatorial Currents.

Another bottle-drift is given by Professor J. D. F. Gilchrist (*Marine Invest. in South Africa*, II. 1904, pp. 155-165, & chart) which in 1917 was apparently unknown to Guppy. This bottle, No. 296, was set off on 11 June 1900, 26½ miles W. of Cape Point, and found on 14 July 1901 on the coast of Pernambuco, having drifted more than 3,400 miles at over 8½ miles per day, taking 398 days for the journey.

The possibility of the appearance of South African seed-drift in West Indian waters is supported by the course of a bottle from Table Bay on 29 April 1909 to Inagua in the Bahamas, where it was found on 10 February 1911, a distance given (*Cape Argus*, 29.8.1931) as 5,000 miles, at a rate of 9 miles per day. The course taken would appear to be that followed by the South African, Main Equatorial, and Guiana Currents.

The first two bottle-drifts illustrate a further point, namely the interconnection of the drift of the Indian and South Atlantic Oceans. That seed-drift may reach the West Coast of South Africa from

regions east of Cape Point is suggested by the course of bottle No. 24 recorded by Schott, which travelled from south of Port Elizabeth to our West Coast at about 33 S. Lat.; and almost as convincingly on a smaller scale, by the course of bottle 108 of the South African series from Cape Hanglip to Saldanha. I have alien drift-seeds from Lambert's Bay on the Clauwilliam coast—*Mucuna gigantea* and *M. myriaptera*—which must have originated in an Old World station on the Indian Ocean.

It has been thought that the course of another of Schott's bottles, which travelled from 41·30 S. Lat. and 32 W. Long. to our coast near the Cape of Good Hope, indicates that South American drift may arrive in temperate South Africa by means of the South African Connecting Current. I have found no definite proof of this in the alien-drift of our West Coast, and it is indeed impossible to say whether drift-seeds of *Caesalpinia crusta* and *Entada* sp., which are also found at Lamberts Bay, have originated in South America or in South Africa. In partial support of the bottle-drift quoted, however, it may be noted that stranded seeds of *Entada scandens* (Keytel), *Caesalpinia crista* (Keytel), and *Dioclea reflexa* (Moseley) have been found in Tristan da Cunha, which is within the sphere of the easterly-flowing South African Connecting Current. The seeds of the *Dioclea* have been preserved at Kew, and the others in Cape Town. Possibly the same current is responsible for the common occurrences of drift-seeds of *Entada* and *Caesalpinia* at St. Helena.

Guppy mentions that Fuegian drift may occasionally be distributed to South Africa (*l.c.* 296, 300), but there is nothing in my seed collection suggestive of this.

#### (b) *The Indian Ocean Coast of Africa.*

On the south and east coast of Africa it may be remarked that this continent is, as on the west, both a receiver and a distributor of drift.

The drift of bottle No. 11 from S.E. of Cape Marie to near Plettenberg bay has been described in Chapter I, the currents concerned being the Natal, the Moçambique, and the Agulhas. No. 14 of Schott's same series was launched N.E. of Port Natal, about one-third of the distance in almost a straight line between Port Natal and Cape St. Marie, and travelled to the neighbourhood of the Knysna coast (*l.c.* Map V). In other words the course corresponds closely with that of the derelict ship "King Cadwallon" to be considered presently. The case of certain seeds, probably peculiar to Madagascar, or of which the Madagascar group is the locality nearest to S. Africa, has also been mentioned in a previous chapter.

But seed-drift may arrive in South Africa from part of the East African Coast. A bottle-drift with a short course is No. 570 of the South African series, which floated from Port Shepstone in Natal to Zitsikamma Point in the Humansdorp Division, 386 miles, at 2·7 miles per day. I am indebted to Captain L. A. Leahy of the Hydrographic Office (Navy Department), Washington, for sending me the following record:—a bottle was cast adrift on 17 November 1934 in 24° 10' S. Lat. and 35° 41' E. Long. (i.e. off Inhambane), and was recovered nine miles east of Mossel Bay on 18 January 1935.

One difficulty in deciding whether our drift-seeds originate in Moçambique or in Madagascar is that those from the former are also native to the latter country. The converse does not always hold, however, as some are peculiar to Madagascar.

South Africa may receive drift from the vicinity of the North West Cape in Western Australia and apparently from part of Malaya. (Guppy *l.c.* 301, 305). Bottle No. 305 of Schott's series travelled from 16 S. Lat. and 98 E. Long. to a point on the east coast of Madagascar shown on his map as between 20 and 25° S. Lat. Two other bottles, Nos. 18 and 38, were set off in mid-ocean only 120 sea-miles from each other in the heart of the South East Trade Current, near 80° E. Long. and approximately 16° S. Lat., of which No. 18 was stranded near Pangani, in East Africa, and the other on the east coast of Madagascar north of the landing place of No. 37. When the South East Trade or Equatorial Current reaches the neighbourhood of Madagascar the drift may be carried either north of it and reach East Africa, or south of Cape Marie and be stranded in South Africa.

If Guppy be correct in deducing that the northern course is taken during the south-west monsoon, and the southern course during the north-east monsoon, the importance of these facts in connection with the route and time of arrival of South African alien drift is evident. Further north the north-east monsoon lasts approximately from December to March (*S. & E. Afr. Yearbook*, 1926, p. 737, under Zanzibar).

The influence of the monsoons together with that of all the factors concerned in the bottle-drifts is perhaps reflected in the wanderings of the fruits of the Seychelles palm, *Lodoicea maldivica*, which I find reported as having been transported by the currents to Chagos, Maldivé and Laccadive Islands, South India, Ceylon, Sumatra, Siam, and Zanzibar. The stranding of a canoe of presumably Malayan origin near Port Elizabeth will be later discussed.

On the other hand South Africa may distribute drift to Australia, as is suggested by the course of bottle No. 31 of Schott's series, which travelled from south-east of Cape Agulhas to the coast of the Great Australian Bight. (*l.c.* Map V).

After studying the work and charts of Schott, some other routes for South African drift-seeds such as *Caesalpinia crista*, *Entada gigas*, and *Sophora tomentosa* are seen to be theoretically feasible. That South Africa may just possibly distribute seeds to East Africa, or even by completing a circuit of the south Indian Ocean, to itself, by way of the West Wind, West Australian and South East Trade or Equatorial Currents may merely be mentioned here.

But additional evidence of the courses of the currents and therefore of the floating seed is, as regards South Africa, afforded by the study of the routes taken by derelicts, floating logs and vegetable refuse, animal-drift, and floating pumice and corals.

#### *Derelict Vessels.*

The log-book of the steamship "King Cadwallon", 5,119 tons gross, which left Durban for Adelaide on 2 July 1929 has been described as a "saga of the seas". (*East London Despatch*,

13.9.1929). On the 8th, when 500 miles east of Durban, fire broke out in No. 2 hold and she put about for that port. The fire having spread to No. 1 hold, the ship was abandoned and the crew taken off by the "Arden Hall"; on 1 August she was sighted by the "Ripley Castle" 400 miles N.E. of Durban; on the 14th by the whaler "Egeland" still 50 miles N.E. of Durban; on the 17th off the Bashee River; and on the 19th off the Chalumna River, whence she was towed into East London where I subsequently saw her. The course should be compared with that of bottle No. 14 of Schott's series.

On 15 February 1927 a canoe of a type which I have seen in the East Indies was washed up at New Brighton near Port Elizabeth. Mr. F. W. Fitzsimons, Director of the Port Elizabeth Museum, informed me that the wood of which this dug-out is made was, at the Forests Products Research Laboratory, Oxford, recognized as Malayan and either *Gluta tavayana* or *Melanorrhoea* sp. (both *Anacardiaceae*). It was probably blown out to sea to come within the sphere of currents already mentioned. Holman mentions that canoes, apparently from Java, have been washed up on the Cocos Islands (Darwin. C., *Voy. Nat.*, Chap. XX); and they are sometimes blown off-shore and transported by the sea for hundreds of miles in Polynesia (Guppy, *P.S. & C.* II 65).

#### *Floating Logs and Vegetable Refuse.*

Trunks of trees, native or alien washed up on the seashore may throw some light, but they are more often than not stripped of their bark and unrecognizable by ordinary inspection. There are many such at Riversdale, some of them from sources further up the coast, but most of local origin:—oak, eucalyptus, fruit trees, *Populus canescens*, *Chilianthus arboreus*, *Salix babylonica*, *Myoporum acuminatum*, *Platylophus trifolius*, *Cunonia capensis*, *Rhus lancea*, and *Acacia decurrens*. One of the largest, however, had stones firmly wedged therein, such as I have not recognized as occurring locally. Darwin (*l.c.*) records a similar instance in the Keelings.

After the disastrous floods in February 1918 at the sugar-cane plantations along the White Umfolosi River in Zululand, great quantities of cane were carried by the Agulhas Current and stranded 800 miles distant at Knysna. This may be compared with the course of bottle No. 570 of the South African series.

Such drifts have and additional interest in that, like pumice and corals, they may be the transporters of small seeds, many of them non-buoyant and not dispersed by water, as well as spores of fungi and marine *algae*. To illustrate this further the writer on 4 January 1930 found a seedling of *Myoporum acuminatum* three inches high growing on a decaying log on the seashore, and on another a seedling two inches high of *Rhus crenata*, both being coast or dune species with non-buoyant, bird-dispersed fruits. The seedlings were at once preserved for the herbarium, and a few days later both logs were washed out to sea. Similarly seeds of *Passerina rigida*, *Osteospermum moniliferum*, *Cnidium suffruticosum*, and *Hebenstreitia cordata*, none of which has any real capacity for flotation, have been found in the hollows or crevices of logs on the

Riversdale coast. *Heliotropium curassavicum*, *Suriana maritima* (also sea-dispersed), *Portulaca oleracea*, and others have been supposed to be dispersed in this way. Drift fruits and seed may also transport spores.

#### *Animal Drift.*

The alien animal drift is also of interest in this connection. The marine turtles *Dermochelys coriacea*, *Thalassochelys caretta*, *Chelone imbricata*, and *C. mydas*, are not infrequently cast up on South African beaches. One of these was stranded within sight of my house, and in November 1928 a gigantic elephant seal, *Macrorhinus leoninus*, was killed almost opposite my front door. Another of the last-named appeared at Port Elizabeth, and was presumed by a zoologist in the press to have come from the Crozet Islands, which are 2,400 miles away. These animals lose their bearings and get into the sphere of the main currents.

The lizard, *Varanus* sp., may have been restored to Krakatau after the eruption on floating logs or by swimming. Other reptiles have been transported on logs to the Keelings. Reference has already been made to the dispersal of animal drift by the Kafirkuijs River near Riversdale, and Purcell discusses the possibility of *Peripatus* being carried on logs from South Africa to South America. (*Mar. Invest. in S. Afr.* II, 1904).

#### *Pumice and Corals.*

The earliest reference which I could find to pumice on the seashore of South Africa is by O. F. Mentzel. (*Desc. of the Cape*, V.R.S., Ed. II, 140). He lived here from about 1732 until 1741. M. P' Abbé De la Caille saw quantities at Mauritius (*Journ.* 1763). It is abundant on our eastern and southern beaches and was observed by the writer at Walvis Bay. If its origin be determined with certainty it affords information about the courses of currents and therefore of the floating seed. Its interest lies also in its being a possible transporter of small non-buoyant seeds.

All pumice on South African coasts is popularly supposed to come from Krakatau. Material sent by me from Riversdale beaches was found by Dr. A. W. Rogers closely to resemble that type; and old inhabitants still remember the arrival of pumice subsequent to the eruption of 26-27 August 1883. Lacroix (*Min. de Madagascar*, III 5) mentions that it appeared in 1884 in Madagascar and the Comoro Islands from Krakatau. Fragments picked up in Réunion 206 days, and in Madagascar 226 days after the eruption, were exhibited to the Academy of Sciences in 1884. The distances travelled are 6,000 and 6,700 km. respectively. Merchantmen passed vast floating areas of pumice between Java and South Africa. (F. W. Fitzsimons, *in litt.* 10.10.1929). I have myself seen quantities in the Strait of Sunda, when a surgeon in the Merchant Service.

A tidal wave at Port St. John's and peculiar sunset appearances in South Africa were recorded in our newspapers of the period.

Dr. Rogers found that other samples of pumice from Riversdale beaches agree well with the description of specimens from Kerguelen, but not from Krakatau. He considered that the Heard Island pumice in the South African Museum is not quite like this Riversdale pumice, but that it is nearer to it than the Kerguelen type.

The writer picked up near Still Bay a large piece of pumice, evidently of Sicilian origin, and certainly part of the stores of a passing ship.

Massive fragments of madrepore, which are unfortunately mostly too worn for precise determination, seem to me to be better suited than pumice for transporting small seeds. They are common on the Riversdale beaches, and one piece in the writer's possession measures 16 by 12 by 6 inches and weighs 14 pounds. They are often encrusted with the same species of organisms as the floating seeds.

#### CLASSIFICATION OF DRIFT SEEDS ACCORDING TO CAUSES OF BUOYANCY.

The presence of seeds in the drift is no proof of effective oceanic dispersal. Their condition, buoyancy, and habitat and distribution of the parent plant, where known, must be considered. But even a capacity for flotation of only a few hours may be of importance to certain true strand-plants. Others without any buoyancy may be spread about mechanically on the seashore, which is not, however, sea-dispersal in the true sense. A good many have been brought by animals, wind and rivers.

Not only are seeds sea-dispersed, but rhizomes and stolons, especially after previous erosion of the soil by wind and wave-action, may be broken off and floated away, becoming the units of dispersal. This may be seen in *Sporobolus virginicus*, *Spartina stricta*, and species of *Zostera*. Pieces of the stems of *Sesuvium portulacastrum* and *Disphyma crassifolium*, in the writer's experience, may be transported for short distances. This he has found to be also true of the bulbils of *Acidanthera brevicollis*.

The method here adopted of classifying drift-seeds according to the causes of buoyancy is that employed by Schimper for East Indian drift-seeds and elaborated by Guppy. I have found it very useful in the determination of unknown material. Guppy has termed groups I and II the mechanical or non-adaptive, and group III the adaptive, groups.

Group I.—Buoyancy due to unoccupied space inside the seed or fruit.

##### 1. Where the seed is concerned.

- (a) Neither the tests nor the seed-contents have any buoyancy. The cotyledons are large, foliaceous, crumpled, or otherwise arranged so that the seed-cavity is incompletely filled.

South African: *Hibiscus tiliaceus*, *H. diversifolius* (doubtful), *Thespesia populnea*, *Dodonaea viscosa*, *Calystegia Soldanella* (introduced by currents), *Calonyction Bona-nox*, *Ipomoea cairica*, *I. carnosa*, *I. spp.*, *Cassytha filiformis*.

Extra-South African: In this category there are *Colubrina asiatica* (near Delagoa Bay) and *Suriana maritima*.

- (b) *Leguminosae*.—Tests and seed-contents without buoyancy, flotation being due to an intercotyledonary cavity.

South African: *Vigna marina*, *V. luteola*, *Caesalpinia crista*, *Entada gigas*.

Extra-South African: *Mucuna* spp. (see Table I).

2. Where the fruit is concerned.

- (a) The seed-contents only partially fill the seed-cavity and are not usually buoyant. The fruit shell may be buoyant.

South African: Not represented, although *Dialium Schlechteri* (which is, however, not truly sea-dispersed though found in the drift), belongs here.

Extra-South African: *Heritiera littoralis*, *Derris trifoliata*, *Gyrocarpus americanus*.

- (b) Due to empty seed-cavity.

South African: *Scaevola Plumieri*.

Extra-South African: None as far as the scope of this paper is concerned.

Group II.—Buoyancy due to floating power of seed-contents.

- (a) Non-leguminous.

South African. None, as true *Ximenia americana* is probably not found within the Union.

Extra-South African: *Ximenia americana*.

- (b) Leguminous.

South African: *Canavalia obtusifolia*, *C. bonariensis*.

Extra-South African: *Strongylodon ruber*, *Erythrina* spp., *Sophora tomentosa*, *Intsia bijuga*.

Group III.—Buoyancy due to aeriferous tissue in tests or fruit-coats.

- (a) Buoyant tissue at periphery of seed or fruit.

South African: *Xylocarpus granatum*, *Barringtonia racemosa*, *Scirpus maritimus* (usually in fresh water localities).

Extra-South African: *Barringtonia asiatica*, *Pemphis acidula*, *Terminalia catappa*, *Lumnitzera racemosa*, *Guettarda speciosa*, *Wedelia biflora*, *Scaevola frutescens*, *Cerbera manghas*, *Cordia subcordata*, *Tacca leontopetaloides*, *Cocos nucifera*, *Sonneratia caseolaris*, *Xylocarpus moluccensis*.

- (b) Buoyant tissue inside testa or inside stone.

South African: None.

Extra-South African: *Mucuna gigantea*, *Hernandia peltata*.

Some of the species mentioned, especially those occurring in the north-east corner of the Union of South Africa, are also found north of Delagoa Bay. Under the designation extra-South African are included here plants with buoyant seeds or fruits growing on the East Coast, the Mascarenes, and those producing most of the alien seeds recorded in Table I.

## SECTION II.

## CHAPTER I.

## THE SEASHORE VEGETATION.

*Introduction.*

The attention of the searcher for drift-seeds on South African beaches is, sooner or later, inevitably drawn to other problems connected with ocean currents. The resemblances of our beach-vegetation—and still more that of East Africa—to that of the eastern shores of the Indian Ocean is one of them. Another is the invasion of our beach-vegetation from the north by a tropical element. As Professor J. W. Bews has aptly said (*Plant Forms*, 1935, p. 31), "The seashore is a uniform easy pathway leading to its own rapid migration of its own characteristic flora of strand plants . . . . One of the most interesting lines of investigation is to observe how the purely tropical species decrease in numbers southwards as the warm sea-current on the eastern side loses its effect and the increasing influence of the cold currents from the south is felt."

In order to show the extent and limits of this tropical invasion an outline of the seashore vegetation of South and East Africa at various stations is given in the present chapter. This is followed by a synopsis of plants, in which, for purposes of comparison, use has been made of Schimper's Indo-malayan list (1891) and the revision thereof by Dr. G. Booberg (1933).

Within the sphere of action of the cold Benguela Current on the west there are some peculiar conditions which deserve mention.

From about the latitude of Mossamedes to south of the Orange River mouth desert conditions exist on the coast. South of the latter, as far as about 31·35 Lat. S., these still persist, but in the southern part of this strip there is already some increase in the strand-vegetation as conditions gradually improve.

Throughout the desert section mentioned there is an absence of a number of plants, which I have myself collected in West Africa to the north and in South Africa to the south of it, to which reference will later be made.

From the latitude last quoted to the neighbourhood of the Bredasdorp division the seashore vegetation is in its main characteristics more temperate than on any other section of our coast: but from there eastwards the warm current begins to make itself more felt, and an increased degree of oceanic seed-dispersal—always more effective in warmer latitudes—is another feature. The Agulhas Current extends in part into False Bay and even doubles Cape Point. The teaching of a modern book on geography may here be cited:—"Following the coast-line and flowing at the rate of three miles per hour, the current makes its junction with the eastern branch of the Antarctic Current some miles to the south of Cape Agulhas." (*Hist. Geog. of S. Afr.*, 1914, 51. Fisher, J. F.). In the *Pilot Chart* for January 1936, sent to me by Captain Leahy of the Hydrographic



Office, Washington, the minimum and maximum drift in miles per day is recorded as from 27 to 100, and of the Moçambique Current, which is its name further north, as from 35 to 105 miles per day.

From west to east three important South African phytogeographical landmarks or signposts are encountered in the following order:—Firstly, the appearance on the eastern border of the Bredasdorp coast of *Scaevola Plumieri*, which extends north to Somaliland. Marloth is incorrect in stating that it occurs on all the shores of the Indian Ocean, and I have found it in South Africa further west than his limit; secondly *Ipomoea Pes-caprae* on the Riversdale coast, occurring as fugitive plants due to germination of washed-up seeds, but permanently a little further east and very abundantly at East London; and lastly the mangrove and its associates. *Avicennia marina* has been reported from near East London, although the writer sought for it there in vain. The associate *Hibiscus tiliaceus*, however, grows there at the Nahoon. The beginning of this more decidedly tropic-like section of the coast may perhaps be said to be nearer the Kei River Mouth, and beyond that point northwards the mangrove and *Barringtonia racemosa* assume more and more importance. The species above-mentioned are all current-dispersed, but there are many others with tropic-subtropic affinities, the migration of which is not in every case assisted by this method of dispersal.

Certain strand-plants extend right round the coast, such as *Sporobolus virginicus*, *Stenotaphrum secundatum*, and *Chenolea diffusa*, the last being found from the Namib to Portuguese East Africa in each of the coastal seres. Others are highly endemic. Climate is very different in different parts of their range from the area of coinciding winter rains and lowest temperature in the west, through that of more equally distributed rainfall, to a region of summer rains and higher temperature in the east. A sandy habit is largely a common factor. It would be impossible here to discuss fully the environmental conditions under which every strand species lives and its complete ecology; or even to give more than a bare outline of its distribution. Most of the plants with tropical affinities are in the following pages recorded successively as they appear in the strand vegetation from west to east; and, along with others which have no such affinities, are summarized in the synopsis.

### *The Namib.*

The Namib is a coastal strip of true desert, extending from the Kunene River near 17 Lat. S. to the Orange River mouth and south of it, which is subjected to the most severe desert conditions in South Africa. The writer's knowledge of plants here is derived from two visits made to Walvis Bay and one to Swakop River Mouth. The beach consists of sand, highly unstable owing to winds, but in parts the coast is rocky—granite and gneiss. What strand plants there are, are mostly driven from the beach, and concentrated around the lagoons and mouths of the rivers, none of which, except the Orange River, is perennial. They consist, moreover, largely of strand grasses also found in other warm countries, and of *Chenopodiaceae*.

*Chenolea diffusa* and *Arthrocnemum natalense* form, as often elsewhere in South Africa, an associates. *Agropyrum distichum* may grow with them, but I saw it chiefly in sand away from the beach.

*Sporobolus virginicus* occurs in isolated colonies in a number of localities, and *Suaeda maritima* at Lüderitzbucht. *Salsola Zeyheri* seemed to the writer to be a dune and not a shore species, in spite of statements to the contrary.

The following, although sometimes found on or near the shore elsewhere, are here dune plants or occur further inland:—*Dactyloctenium aegyptium*, *Eragrostis cyperoides*, *E. spinosa*, and *Juncus laevigatus*.

*Gyrocarpus americanus*, which in some countries is found on the coast near the sea, grows in South West Africa only inland. Another inland species here belongs to *Ximenia*, but is probably not *X. americana*, which is a littoral plant of much of the tropics.

The following seashore or partly inland plants appear near the Orange River estuary:—*Hebenstreitia cordata*, *Sporobolus virginicus*, *Eragrostis cyperoides*, *Scirpus littoralis*, *Statice scabra*, *Spergularia* spp., *Frankenia pulverulenta*, *Heliotropium curassavicum*, *Chenolea diffusa*, and *Arthrocnemum natalense*.

The picture is that of a scanty vegetation clinging to special localities, exposed to the full influence of the Benguela current, and showing modifications of, and agreements between, form and structure on the one hand and habits of life and environment on the other. It displays such features as narrow, sometimes pungent, sometimes glaucous leaves, with involute or revolute borders; rigid pungent branches; various degrees of hairiness, creeping rhizomes, and multi-rooting stolons.

#### *Lamberts Bay.*

From the mouth of the Olifants River southwards the strand vegetation gradually increases. At Lamberts Bay the annual rainfall is from nine to ten inches, most of which occurs during winter.

The most common halophyte is *Cryptostemma niveum*. *Aizoaceae* here seem to possess the sites usually occupied by *Scaevola Plumieri* and *Ipomoea Pes-caprae* elsewhere, but the distribution of the two latter is interrupted here along this coast by the influence of the cold Benguela Current. The chief *Aizoaceae* are *Carpobrotus edulis*, *Caryophytum* sp., *Drosanthemum* spp., *Tetragonia decumbens* var. *ovalifolia*, as well as one or two others unknown to the writer. *Sporobolus virginicus*, *Hebenstreitia cordata*, and *Osteospermum moniliferum* were present on the upper beach and near the base of the dunes.

The Jakhals River was cut off from the sea by a sand-bar, a lagoon being formed. On the muddy shores of this *Chenolea diffusa* and *Arthrocnemum natalense* were common, and outside this zone *Heliotropium curassavicum* and *Polygonum maritimum*. ... ..

On low rocks a lichen, *Caloplaca* sp., formed large red splashes, and *Chironia baccifera*, *Sporobolus virginicus*, and a species of *Drosanthemum* were pioneer plants.

No strand-plant here produces seeds which are buoyant.

#### *Blaauwberg Strand.*

At Blaauwberg Strand the annual rainfall is 15.02 inches, of which 77 per cent. falls during winter. The more favourable climatic and edaphic conditions are reflected in the greater size of

the consociates. But since the total of all South African obligate halophytes is comparatively small, the increase in this respect is not striking. On the mid- and upper-beaches were noted:—*Cryptostemma niveum*, *Dimorphotheca fruticosa*, *Salsola Kali*, *Plantago carnosa*, and *Anthericum revolutum*. Further away from the beach were found *Ficinia lateralis*, *Silene crassifolia*, *Hebenstreitia cordata*, *Cnidium suffruticosum*, *Senecio maritimus*, *Apium graeveolens*, *Eragrostis cyperoides*, and *Myrica cordifolia*. With regard to *Passerina ericoides*, which occurs at the base of and on the dunes, Professor D. Thoday makes the significant remark applicable also to some true strand plants:—"It has not been found in the neighbourhood of Saldanha Bay. Probably the diminishing rainfall limits its northward migration". Where there was more moisture, there occurred *Frankenia laevis*, *Spergularia* spp., and *Juncellus laevigatus*—all in brackish localities. *Juncus maritimus* was growing on the outer border of the halosere as it does at Riversdale, but *Scirpus maritimus* as elsewhere belied its specific name. The *Chenolea-Arthrocnemum* associates was again present.

### Cape Peninsula.

False Bay, as compared with Table Bay, has a higher mean annual temperature, higher mean temperature for January and July, higher surface sea-temperatures, and a greater amount of precipitation. Sandy beaches are more extensively developed on the eastern side. The rocks on the coast belong mainly to the Table Mountain and Malmesbury series, with quartz-porphry granite intrusive in the latter.

All the plants mentioned as occurring at Blaauwberg Strand are found in the Cape Peninsula, and in the main in similar localities. But when they are compared with those of the Riversdale coast we still note the absence of *Scaevola Plumieri* in the Peninsula, and the presence of more tropical vegetal tendencies in Riversdale.

*Chenopodiaceae* are comparatively strongly represented, and comprise *Salicornia meyeriana* and about five species of *Arthrocnemum*, one of *Suaeda*, and *Chenolea diffusa*. I have had the advantage of the kindness of Mr. N. S. Pillans, who has a long special acquaintance with the Flora of the Cape Peninsula, and who revised my Table II, which I have drawn up to show most of the seashore plants of that region and to admit of comparison with those of other areas.

The position of *Passerina rigida* here is interesting, as it reaches the upper-beach in Riversdale and Knysna.

*Zannichellia palustris* occurs in freshwater localities and is now evidence merely of a former connection with the sea. *Scirpus maritimus* is widely distributed inland where the water is fresh.

The common seashore orange lichen on granite was named for me by Professor P. A. van der Byl as *Caloplaca murorum*. He has recorded the following from coastal rocks in the Cape Peninsula:—*Combea mollusca*, *Rocella fucoides*, and *R. hypomecha*. *Bredasdorp Coast*.

On the Caledon coast the species found by me were the same as those in the Cape Peninsula.

At Cape Agulhas, near which the greater part of the main current turns away from the South African coast, the following were found by me:—*Chenolea diffusa*, *Tetragonia decumbens*, *Dimorphotheca fruticosa*, *Plantago carnosa*, *Sporobolus virginicus*, *Drosanthemum* sp., *Statice scabra*, *Zygophyllum Morgsana*, *Arthrocnemum* (probably *A. litoreum* Moss), and others. *Caloplaca murorum* was the common rock lichen.

At Struis Bay, several miles further eastwards, nothing of interest was found. *Scaevola Plumieri* was specially sought for but unsuccessfully.

TABLE II.

	Sandy beach.	Rocks on Shore.	Shingle.	Salt marshes.	Ground water brackish to fresh.	Fore-dunes.	Inland
<i>Sporobolus virginicus</i> .....	×	×			×		
<i>Paspalum vaginatum</i> .....	×						
<i>Eragrostis glabrata</i> .....	×					×	
<i>Eragrostis cyperoides</i> .....	×					×	
<i>Stenotaphrum secundatum</i> .....	×					×	×
<i>Agrophryum distichum</i> .....	×					×	
<i>Juncellus laevigatus</i> .....	×					×	
<i>Scirpus littoralis</i> .....				×	×	×	
<i>Scirpus maritimus</i> .....				×	×		
<i>Ficinia lateralis</i> .....					×	×	
<i>Triglochin striatum</i> .....				×	×		
<i>Triglochin laxiflorum</i> .....					×		
<i>Ruppia spiralis</i> .....					×		
<i>Zannichellia palustris</i> .....					×		×
<i>Juncus maritimus</i> .....				×	×		
<i>Anthericum revolutum</i> .....						×	
<i>Chenolea diffusa</i> .....	×				×		
<i>Salicornia &amp; Arthrocnemum</i> .....	Six species	in the	halosere.				
<i>Suaeda</i> sp.....	×			×			
<i>Salsola Kali</i> .....	×			×			
<i>Apium graveolens</i> .....					×		
<i>Apium australe</i> .....	×			×	×		
<i>Seseli asperum</i> .....	×					×	×
<i>Cnidium suffruticosum</i> .....	×					×	
<i>Helichrysum retortum</i> .....	×	×				×	
<i>Dimorphotheca fruticosa</i> .....	×	×					
<i>Cryptostemma niveum</i> .....	×					×	
<i>Senecio maritimus</i> .....	×						
<i>Felicia ficoides</i> .....				×	×		
<i>Matricaria sabulosa</i> .....	×			×		×	
<i>Gazania</i> sp.....			×				
<i>Cotula coronopifolia</i> .....					×		×
<i>Lobelia halophila</i> .....		×					
<i>Orphium frutescens</i> .....	×				×		
<i>Chironia baccifera</i> (coast form).....	×	×				×	
<i>Chironia maritima</i> .....				×	×		
<i>Samolus Valerandi</i> .....	×			×	×		
<i>Erodium malachoides</i> .....	×					×	×
<i>Plantago carnosa</i> .....	×					×	
<i>Hebenstreitia cordata</i> .....	×	×				×	
<i>Manulea tomentosa</i> .....	×					×	×

	Sandy beach.	Rocks on Shore	Shingle.	Salt marshes.	Ground water brackish to fresh.	Fore-dunes.	Inland.
<i>Zaluzianskya maritima</i> .....	×					×	×
<i>Statice scabra</i> .....	×	×		×			×
<i>Statice linifolia</i> .....	×			×			
<i>Pharnaceum cordifolium</i> .....	×						
<i>Carpobrotus edulis</i> .....	×	×	×			×	×
<i>Drosanthemum (?) candens</i> .....	×	×					
<i>Tetragonia decumbens</i> .....	×	×					×
<i>Disphyma crassifolium</i> .....	×	×		×	×		
<i>Frankenia laevis</i> .....	×			×	×		×
<i>Frankenia pulverulenta</i> .....	×			×	×		×
<i>Spergularia rubra</i> .....	×			×	×		×
<i>Spergularia marginata</i> .....	×			×	×		×
<i>Silene primulaeflora</i> .....	×					×	
<i>Cassine maritima</i> .....	×					×	
<i>Maurocenia frangularia</i> .....		×					×
<i>Myrica cordifolia</i> .....	×					×	
<i>Polygonum maritimum</i> .....	×				×		
<i>Lycium tetrandrum</i> .....	×	×					

### Swellendam Coast.

*Scaevola Plumieri* grows extensively on both sides of the Breede River estuary and for some distance west of it in the Bredasdorp Division. It associates with *Myrica cordifolia*, and in places extends inland for as far as eight hundred yards on the dunes. In early August I have observed few fruits on the shrubs here, although at that time they were abundantly present on the Riversdale coast only forty miles eastwards. A species of *Drosanthemum* with greyish foliage was common near the shore on limestone rocks.

### Riversdale Coast.

On the front sandy beach I found that only a few plants of *Arthrocnemum veriiflorum* and *Agropyrum distichum* appear.

On the mid-beach there are the following:—*Sporobolus virginicus*, *Hydrophyllax carnosus*, *Cnidium suffruticosum*, *Hebenstreitia cordata*, *Apium graveolens* (also in rock-crevices), and *Othonna lapidosa* Hutch & Dyer. The last is an unpublished, succulent suffrutex found by the writer. (Muir 3128!)

Four plants owe their presence in this position to the germination of current-borne seeds, viz.:—(1) *Ipomoea Pes-caprae*, of which most of the seedlings soon die, but a few plants attain a height of from three to eight inches and live for a few months. No flowers are produced in this high latitude. (2) *Calystegia Soldanella*; (3) *Canavalia obtusifolia*; (4) Isolated seedlings of *Scaevola Plumieri* from "stones" of local or more distant origin. It is noteworthy that these plants all occur at or near the level of the drift.

On the upper-beach we again meet with the same plants as on the mid-beach, the following being a more or less complete list:—*Sporobolus virginicus*, *Dimorphotheca fruticosa*, *Cnidium suffruticosum*, *Chenolea diffusa*, *Statice scabra* (which may occur on rocks and in stony places like *S. Armeria*, or in the halosere on saline loams like *S. Limonium*, both in Europe), *Cryptostemma niveum*, *Agropyrum distichum*, *Indigofera tomentosa*, *Othonna lapidosa*, *Disphyma crassifolium*, *Passerina rigida*, *Gazania uniflora*, *Plantago carnosae*, *Salsola Kali*, *Stenotaphrum secundatum*, *Ficinia lateralis*, *Carpobrotus edulis*, *Hebenstreita cordata*, *Chironia baccifera* (the coast variety *Burchellii*, which has succulent, often deformed, shorter and broader leaves; the typical form appearing further away from the coast), *Myrica cordifolia*, *Psoralea bracteata* var. *Algoensis* (here with prostrate or decumbent branches, but more erect further back), *Cassine maritima* (the drupes, I found, were initially buoyant, and 36 per cent. of them were still afloat after 50 hours, although dispersal is due to other agencies), *Cryophytum crystallinum*, *Helichrysum ericaefolium*, var. *albidulum*, *Leontonyx spathulatus* var. *candidissimus*, *Helichrysum teretifolium*, and *Anthericum revolutum*.

All the above species may, if only occasionally, be inundated by the sea.

On the low foremost dunes *Scaevola Plumieri* constitutes the most striking consociates on the Riversdale coast. The site is from 5 to 40 feet higher than the upper-beach, on a ridge which with short interruptions extends for miles. At times great areas of the plant are destroyed by gales or wind erosion. In a previous paper the writer has described, near the mouth of the Kafirkuils River, hillocks which had been formed and covered by this plant over a long period of years. (Muir, J. *Veg. of Riversdale Area*, 1929.) These have now disappeared. Children, cattle, and donkeys loosened the sand, and the extirpation of the plant was completed by gales from the sea, waves, and river-floods. The thick stems and rhizomes, however, which run deeply are good sand-stayers. It associates with *Passerina rigida*, *Osteospermum moniliferum*, *Osyris abyssinica*, and often with *Agropyrum distichum*.

I have found the following insects on the flowers, which were determined for me by Dr. A. J. Hesse:—*Xylocopa sicheli* Vach. (a boring genus, and a carpenter bee), *Apis mellifica* probably var. *andersoni*, *Allodape nigripes* Fries: these are all *Apidae*; *Bembex melanopa* Hand. race *littoralis* Arn. (*Sphégidae*). An *Anthophora*, a *Polistes*, and *Myrmicaria nigra* (an ant) were also noted. Some of these may be connected with pollination, but the flowers are proterandrous, the anthers shedding their pollen within the bud, and this is collected by the indusium surrounding the stigma.

The older, leached-out portions of the beach, which contain more humus and clay, are occupied by an interesting list of invaders:—*Sutera tristis*, *Manuela tomentosa*, *Aster capensis*, *Senecio elegans*, *Crassula expansa*, *Cephalophyllum maritimum*, *Mesembrianthemum gracile*, *Lampranthus diutinus*, *Euphorbia Muirii*, *Tetragonia decumbens*, etc.

Certain seeds appear in the beach-drift, which are not really sea-dispersed, and this may be explained in several ways as already mentioned. Here for example *Sideroxylon inerme* (in a stunted coast form), *Azima tetraantha*, *Euclea racemosa*, *Zygophyllum Morsana*, *Rhoicissus Thunbergii*, *Olea exasperata*, and other shrubs, may extend right down to and even overhang the upper-beach, especially in places where the dunes slope steeply to the sea. This is also true of other plants on other sections of the South African coast.

There is another reason, however, for the appearances of seeds of non-buoyant species on the beach. Numerous fountains, many alternately covered and exposed by the tides, bubble and ooze from the beach, which are resorted to by birds, baboons, cattle, and other animals, and these void such seeds as *Osteospermum moniliferum*, *Podocarpus elongata*, *Acacia karroo*, *A. saligna*, and *Olea capensis*. I took seeds of the first of these from the excrement of oxen, and found that they produced seedlings 23 days later, and similarly with seeds of the Acacias. In Hawaii *Acacia farnesiana* has been dispersed by cattle in this way. (P.S. & C. 169.) Thus some of these plants may actually appear and grow for a time on the Riversdale beaches. I have also noticed seedlings of *Myoporum acuminatum* on the beach due to the agency of birds.

Riversdale coast plants show in the psammosere many of the characteristics of those in similar localities in other lands:—

1. Inrolled leaves: *Sporobolus virginicus*.
2. Thickened epidermis: *Othonna lapidosa*, *Scaevola*, *Sideroxylon*, etc.
3. Hairiness: Some inland plants, e.g. *Sutherlandia*, *Helichrysum cricaefolium*, and *Leontonyx spathulatus* are represented here on the strand by extremely hairy varieties.
4. Glaucous or waxy bloom: *Othonna*, *Hebenstreitia*.
5. Vertical arrangement of leaves.
6. Rosette form of leaves: *Statice scabra*, and further east *Lamnaca*. This was regarded by Schimper as a characteristic strand-form in Malaya.
7. Stems with little ligneous tissue: *Othonna lapidosa*.
8. Prostrate habit: Plants of the same species becoming more erect inland.
9. Stunting and deformity according to proximity to sea.
10. Succulence of leaves, stems, and, as in *Anthericum* and *Othonna*, of roots. The same species may show more mesophytism inland.
11. Creeping rhizomes and stolons. This is more common nearer the sea.
12. Adaptation of root system to amount and depth of moisture.
13. Leaves and stems becoming later reddish: *Arthrocnemum variflorum*, *Chenolea diffusa*, *Statice scabra*. In Mozambique *Sesuvium portulacastrum* is a striking example.
14. Ability to withstand temporary burial in sand: *Scaevola*, *Sporobolus*, *Cryptostemma niveum*, *Ficinia lateralis*, *Hydrophyllax carnosa*, and *Agropyrum distichum*.

In the salt-marshes, *Zostera marina* or its variety *angustifolia* is an aquatic, and on the mud occur *Spartina stricta*, *Salicornia meyeriana*, *Arthrocnemum africanum*, *A. natalense*, and *A. variiflorum*. The composition of this mud appears in a later chapter, for comparison with that supporting *Rhizophora mueronata* in Portuguese East Africa.

Where the flats are higher I found *Chenalea diffusa*, *Spergularia marginata*, *Frankenia laevis*, *Sporobolus virginicus*, *Cotula coronopifolia*, *Samalus Valerandi*, *Orphium frutescens*, *Statice linifolia* and *Juncus maritimus*. Furthest away from the sea, where the water-content of the soil is practically fresh, occur *Triglochin striatum*, *Aster ficoides*, *Stenotaphrum secundatum* and *Falkia repens*.

On coastal rocks occur *Arthrocnemum litoreum* as a small gnarled shrub, and *Gazania uniflora*. Very many of the upper-beach species already recorded are found here. There are no very definite or peculiar rock or cliff plant associations, such as those in some other countries.

There is, similarly, nothing that is peculiar to the shingle beaches, where the chief plants are *Sporobolus virginicus*, *Solanum quadrangulare*, *Statice scabra*, and *Gazania uniflora*.

#### LICHENS ON RIVERSDALE COAST.

These are interesting because of Schimper's statement about their paucity in, or even absence from, certain mangrove regions of the Indian Ocean littoral. I have collected the following on sandstone quartzite rocks or trees, within reach of the spray in many cases but in others beyond it:—*Caloplaca murorum*, *C. subseptata*, *C. cinabarina*, *C. granuliformis*, *Blastenia ferruginea*, *Xanthoria parietina*, *Rocella hypomecha*, and *Parmelia* sp., which were determined by Professor P. A. van der Bijl. They do not, I find, readily obtain a footing on arenaceous, eroded, crumbling, recent limestone.

*Chenopodiaceae* are again the family most strongly represented. Only two or three out of about 170 species of *Leguminosae* found in the Riversdale Division extend to the dunes and strand.

The Riversdale coast is rather a receiver than a distributor of seed-drift, seeds of *Scaevola Plumieri* being really the only drift-export.

#### Mossel Bay, George and Knysna Coasts.

There is little on these coasts not already recorded from elsewhere, with the notable exception of *Ipomoea Pes-caprae* which is a permanent constituent of the strand-flora. *Chaetacanthus Persoonii* occurs at Little Brak River, and in Natal it is present in the initial stages of the halosere. A littoral form of *Mariscus congestus* is found at the base of and on the dunes, but it becomes more common further eastwards in the "*Pes*". *Solanum Aggerum* is recorded only from Knysna, in the same position as *S. quadrangulare* at Riversdale, the two species being closely allied. It associates on the dunes and upper limits of the beach with *Rhus crenata*, *Passerina rigida*, and *Scaevola Plumieri*. *Cryptostemma niveum* forms much larger consociates than at Riversdale, and the same is true of some of the other more tropic species.

*Rocella linearis* is found on the rocks at the Knysna Heads.



### St. Francis Bay.

*Cordia caffra*, an inland tree-veld species of the coastbelt, becomes a prostrate bush on the dunes and in some places is exposed to the spray. It is worthy of mention here as a member of a tropical genus, of which *Cordia subcordata* is a classic example of sea seed-dispersal.

### Algoa Bay.

The "Pcs" is not yet extensive. *Vigna luteola*, a common sea-dispersed species of the tropics and sub-tropics, now appears on the dunes and in coast vleis. *Scleropoa rigida* and *Gasteria Croucheri* have been mentioned by one writer as strand-species here, which however, is incorrect. *Myrsine gilliana* collected "on the shore" by C. F. Ecklon and K. L. P. Zeyher is also not a true strand-plant. *Acanthus ilicifolius*, a typical mangrove associate of the East, is recorded from Uitenhage, apparently introduced. *Heliotropium curassavicum*, *Spartina stricta* and *Suaeda maritima* occur here; and in brackish water are found *Althenia austro-africana*, *Chara stachymorpha*, *C. macropogon* and *Lamprothamnium papulosum* according to Miss E. L. Stephens. *Ipomoea cairica* grows in the coastbelt forests, river bush, and dune-scrub, but not on the strand, and produces buoyant seeds which are found in the beach-drift. Algoa Bay is approximately the eastern limit for *Chironia maritima* and *Zygophyllum Morgsana*, and the western for the small tree *Brachylaena discolor*.

### Bathurst Coast.

*Dactyloctenium aegyptium* may occur on the upper-beach, but it is found more usually further away from the sea on the dunes. A species of *Halophila* grows among the glassworts. *Statice scabra* and *Hebenstreitia cordata* attain here approximately their eastern limits, and the Great Fish River is the western limit of *Acidanthera brevicollis*.

### East London Coast.

The latitude of East London is only about 1.25 degrees lower than that of much of the Riversdale coast. Nevertheless the tropical element in the strand vegetation is already here considerably greater, which may partly be ascribed to the increasing influence of the warm current.

*Aricennia marina* and *Hibiscus tiliaceus* appear, but the latter tree as far as Port St. Johns is very much smaller than it is north of that station. *Arthrocnemum* is once more well represented. On the sandy shore are:—*Sporobolus virginicus*, *Euphorbia livida* (a glabrous perennial with prostrate or decumbent branches, forming patches), *Helichrysum litorale*, *Plantago carnosae*, *Salsola Kali* (very abundant), *Gazania uniflora* and *Carpobrotus edulis*. *Ipomoea Pes-caprae* forms well-developed consociates or associates with *Mariscus congestus* and *Scaevola Plumieri*. The *Ipomoea* is, however, much more luxuriant to the north, but the contrast with the miserable seedling plants on the more temperate Riversdale coast is very striking. The coast form of *Mariscus congestus* is a good sandstayer, having a short rhizome, sometimes stoloniferous, rooting deeply. Other species here are *Rhus crenata*, *Cynanchum natalitium*, *Silene*

*primulaeflora*, and *Osyris abyssinica*. *Dactyloctenium* and *Stenotaphrum* are found away from the more extreme saline areas. *Cryptostemma nivicum* forms large pure consociates, which are in some places within the *Pes*, but in others are nearer to or further away from the sea than the latter.

*Canavalia obtusifolia* grows at the junction of the strand and the scrub; *Vigna luteola* scrambles over low shrubs in the *Pes* and also occurs in periodical coast marshes; *Astephanus marginatus* sends out prostrate stems over the sand from the border of the scrub.

The plants on the cliffs and rocks are *Maba natalensis*, *Osteospermum moniliferum*, *Chironia baccifera* var. *dilatata*, *Cryophytum Aitoni*, *Plantago carnosa*, and *Chenolea diffusa*.

East London appears to be more or less the eastern limit of *Myrica cordifolia*, *Rhoicissus Thunbergii*, and some other plants. *Transkei* and *Pondoland Coasts*.

At about 32-40 Lat. S. the mangroves *Rhizophora mucronata* and *Bruguiera gymnorhiza* are found on the marshy estuaries, lagoons, and creeks. This is the southern outpost in Africa of the "Eastern Mangrove" which extends to Polynesia; and, as it also includes here *Aricunna marina*, it remains "mixed" to the end. Near Port St. Johns I saw *Bruguiera* far from the sea surrounded by a stretch of *Juncus maritimus*, and associating also with *Triglochin striatum*, *Apium graveolens*, *Phragmites communis* and *Cyperus textilis*, in a locality where the watery medium is only slightly saline. *Hibiscus tiliaceus* is dominant along the creeks at a higher level than the swamps. I did not observe *Barringtonia racemosa* or *Chrysodium aureum*; but *Zostera marina*, *Mariscus dregeanus*, *Fimbristylis obtusifolia*, and *Arthrocnemum natalense* occur in the holosere. *Juncus laevigatus* grows on the beaches, standing in some localities in water.

*Ipomoea Pes-caprae* forms a luxuriant and extensive covering on the dunes. *Passerina rigida* at Port St. Johns grows behind the zones of *Scaevola* and *Ipomoea* as a general rule, and only exceptionally within them. *Asystasia coromandeliana*, although not a true strand-plant, is common everywhere and helps to mat the sand together. On the upper beach are:—*Cryptostemma nivicum*, *Helichrysum terctifolium*, *Dimorphotheca fruticosa*, *Statice linifolia*, and *Cynanchum natalitium*; while on the dunes and outskirts of the scrub occur *Canavalia obtusifolia*, *Anthospermum litorum*, *Cardiospermum Halicacabum*, *Brachylaena discolor*, *Mimusops caffra*, and *Olea* spp. *Ficinia lateralis* and *Scirpus maritimus* appear not to go much further east than Komgha.

#### *Natal and Zululand Coast.*

The first view of the strand vegetation of this section of the coast is eminently delightful, and although we are not in the tropics, it brings back pictures of them to the mind. The chief features are the greater development than hitherto of megatherm species, the mangrove, the *Barringtonia*, and the associates of these, as well as of *Ipomoea Pes-caprae* and *Scaevola Plumieri*. The presence of a warm current on the coast has caused latitude to be

here a term of equivocal significance, and many of the strand and neighbouring swamp-species are classical in the literature of oceanic seed-dispersal.

The mangrove, however, still consists of only three members, viz. *Avicennia marina*, *Rhizophora mucronata*, and *Bruguiera gymnorhiza*. The first of these sometimes forms a sort of "wall" facing the water, and between it and the interior. The *Rhizophoraceae* associate with *Barringtonia racemosa* and, on the raised swamp-margin, with *Hibiscus tiliaceus*. At a still higher level this *Hibiscus* is, as recorded by Bews, found with *Voacanga Dregei* and *Eugenia cordata*. An associate of the mangrove, of almost world-wide distribution in similar localities, is also present here, the fern *Chrysodium aureum*.

*Thespesia populnea* is found on the coast of Zululand, and in the same region appear *Entada gigas* in the *Barringtonia*, and *Caesalpinia erista*. The last lies chiefly behind the first low sandy ridge above the beach.

Associates not previously recorded from the *Pes*, are *Cyperus natalensis*, with long rhizomes,  $\frac{1}{8}$  inch thick; and *Launaea bellidifolia*, with runners rooting and producing fresh rosettes of leaves at intervals. Partly in the *Pes*, and partly in the belt above it are:—*Canavalia obtusifolia*, *C. bonariensis*, *Tephrosia canesceus*, *Schizoglossum euphorbioides*, *Cynanchum obtusifolium*, *C. capense*, *C. natalitium*, *Passerina rigida*, and *Heliophila scandens*. *Vigna luteola* is common here and among dune grasses, but is found also behind the dunes in vleis which are not even brackish. *V. marina* is very rare, and has been collected in similar coast-vleis on the south coast of Natal and at Umgeni. In Java, where they are regarded as belonging to one species—*V. marina*—the habitat is definitely the sandy strand. *Lippia nodiflora* occurs in sandy places near the sea, *Cassytha filiformis* in the *Pes* and on the dunes, and *Dodonaea viscosa* in the coast scrub. *Randia dumetorum* and *Perotis indica*, which have habitats in Natal which differ from those in the East, are recorded in the Synopsis.

Some halosere species here are:—*Salicornia meyeriana*, *Arthrocnemum natalense*, *Chenopodium diffusa*, *Scirpus littoralis*, *Fimbristylis obtusifolia*, *Mariscus dregeanus*, *Triglochin laxiflorum*, *Spergularia media*, *Juncus maritimus*, and *Chaetanthus Persoonii*.

In comparison with Schimper's statement about the rarity of lichens in the Indo-malayan, and their absence from the Ceylon mangrove, the frequent occurrence here of *Lecidea bruguierae*, *Buellia bruguierae*, and *Haematomma puniceum* on *Bruguiera gymnorhiza* may be mentioned.

Some common species on the Zululand coast at Emalangeni are *Ipomoea Pes-caprae*, *Seacrota Plumieri*, *Sporobolus virginicus*, and *Carpobrotus edulis*, with *Ostcospermum moniliferum* further away from the sea. *Canavalia obtusifolia* and similar strand plants are plentiful.

#### *Bahia de Lourenço Marques.*

Lourenço Marques is situated about 230 miles north of Durban and 120 miles south of the tropic. The strand vegetation is even more markedly than heretofore of the Indo-malayan type, only the *Nipa*

“ formation ” being absent. The main communities are (1) the *Pes-caprae* and (2) the *Barringtonia* which are on sand, and (3) the Mangrove which is chiefly on tidal mud.

#### THE PES-CAPRAE.

The shores of the bay proper consist of open sandy beaches backed by low sandy dunes twenty or thirty yards wide, on which *Ipomoea Pes-caprae* is dominant; but in places *Scaevola Plumieri* ranks equal in importance. On the beach itself *Sporobolus virginicus* is the pioneer. The following are found in the *Pes*:—*Cyperus maritimus*, stoloniferous, rooting deeply and matting the sand; *Lawnaea bellidifolia*, with runners giving rise to rosettes of leaves at intervals; *Tephrosia canescens*, a silvery suffrutex, deflorate during June and July; (the seeds of this were not obtainable but are probably non-buoyant); *Cassipoua filiformis*; *Lippia nodiflora*, a creeping perennial, rooting at the nodes; *Asystasia coromandeliana*, over-running the *Pes*, possessing considerable powers of sand-fixation; *Canavalia obtusifolia*; *Brachylaena discolor*, a shrub or small tree, 10 to 15 feet high, but also found further away from this area; *Caesalpinia erista*, a scandent but non-twining, thorny, and bramble-like shrub. It was noted here in 1876 by Mrs. Rose Monteiro, and is common in sand behind the foremost low sandy ridge. When no support is available the branches arch outwards and lie on the ground; but on trees, ruins, old iron girders, and in the outer drier portion of the mangrove, it reaches a length (or height) of ten feet or more. Owing to the low ridge mentioned the seeds would probably have difficulty in reaching the sea, by which they are dispersed.

*Colubrina asiatica*, *Wedelia biflora*, and *Sophora tomentosa* are found on the sandy shores of the mainland and neighbouring islands, where the sand often rests on coral. It is worthy of note that in Java the last-mentioned plant is also regarded as being partial to lime. (C. A. Backer, l.c. 147).

*Pretraca zanguebarica*, a perennial trailer, occurs in the *Pes*; and further back I saw, as at Riversdale, *Azima tetracantha* and *Osteospermum moniliferum*.

Mr. Hubbard pointed out to me at Kew that the grasses *Dactyloctenium germinatum* Hackel and *D. aegyptium* (L.) Beauv. meet here. The latter occurs on the upper-beach, not so close to the sea, and between it and the psammophilous bush.

The following species have been planted in clearings in the *Pes* near the beach:—*Hibiscus tiliaceus*, *Cocos nucifera*, *Terminalia catappa*, *Aleurites triloba*, *Moringa oleifolia*, and *Jatropha Curcas*. *Casuarina equisetifolia*, *Aleurites triloba*, and *Terminalia catappa* are made use of as street trees in the coast towns of Moçambique. The first-named is found on the dunes of the coast.

#### THE BARRINGTONIA.

*Barringtonia racemosa* forms forests along the Inkomati River in wet sandy soil. The river even at high tides is at most only slightly brackish. This tree attains a height of 15 to 20 feet, and has white or pale-cream flowers, few of which were to be seen during the time of my visit in June-July. The mangrove was not noted as a constituent, but it may occur on the forest-margin.

The floor of the forest was thickly strewn with fallen fruits of the tree and covered with young seedling-plants a foot or so in height. As contrasted with the cheerful interior of a mangrove forest it impressed me as somewhat gloomy. Nevertheless, although here comparatively little sunlight reaches the ground, I have seen less light still in the psammophilous scrub with *Sideroxylon inerme* dominant, and also in the sub-tropical eastern high forest of the Riversdale Division. Walking was easier through the forest itself than through the surrounding belt of *Phragmites communis*. In most of it inundation by the river occurs, bringing fragments of the culms of *Phragmites* and other debris, which are mingled with the fruits of *Barringtonia* and the pods and seeds of *Mucuna gigantea*. The forest area varies in width from a few up to 50 yards; but although *Barringtonia* often grows in somewhat drier sandy areas, extension inland ceases when the ground becomes steeper, and the tree is never found far from water.

The stems of *Entada gigas* extend far and wide, the main base being in some cases over 56 inches in circumference. Somewhat smaller here are the lianes of *Mucuna gigantea*, the base of which may be 24 inches in girth. On section they exude water copiously, and the flowers of both appear high up, where light and air are better obtainable. While the stems of *Entada* twist round their supports, those of *Mucuna* on the other hand climb without doing so. *Mucuna gigantea* was not recorded as growing wild in Mozambique until it was proved to be conspecific with *M. quadrialata* Baker from my collections made here. (K.B. 9, 1931, Dyer, R.A.) It is also found on and among *Phragmites* outside the forest.

In Fiji *M. gigantea* belongs to the mangrove and the area between it and the beach. In Malaya it is widely distributed, but only on the strand and in its neighbourhood.

On the river bank *Barringtonia racemosa* associates with *Hibiscus tiliaceus*. Further back *Cocos* and *Casuarina* are cultivated, and behind these again the following, which, although not strand species, have fruits or seeds appearing as accidental constituents of the local drift of the river and seashore:—*Anacardium occidentale*, *Dialium Schlechteri*, *Jatropha Curcas*, and *Conopharyngia elegans*. The last may occupy sites very similar to those of *Voacanga Dregei* in Natal.

*Frullania diptera* and *Macromitrium lycopodioides* are mosses which are found here on the bark of *Barringtonia*.

The animal associates of the *Barringtonia* are of interest. Insects are fairly numerous. Kingfishers and non-limicole birds were observed, and in the deeper reaches of the river hippopotami and crocodiles. The fruits of *Barringtonia* lying on the ground showed in some cases inroads made by borers.

As compared with Durban, the *Barringtonia* at Lourenço Marques has more associated species and is in this respect more tropical. In East Africa it includes many of the ocean-dispersed species which are still more numerous in Indo-malaya.

## THE MANGROVE.

The mangrove swamps are not dismal in appearance except when viewed at low tide from the river across the bare mud flats. Seen from the interior the forest is not closed; the light is bright and not dim; the marshes are in great part not impassable, they are not ill-smelling, and from the point of view of health they are probably not worse than sandy beaches in the vicinity. During the winter months insects are not troublesome. The temperature for June and July averages  $72.1^{\circ}$  F. and  $73.6^{\circ}$  F. respectively. Although access from the Rio do Espirito Santo is often impossible, a landing may be made where the covering layer of mud is thin and resting on firm sand. Entrance from the landward side is, as in other parts of the world where such swamps exist, easy; and progress is not difficult until impeded by the intersecting muddy creeks.

"The mud of the swamps along the estuaries contains a fair amount of clay. Since the streams entering the Inkomati River some way east of Lebombo run over Cretaceous and Tertiary limestones there is some finely divided limestone in it as well. The bulk of the mud is likely to come from the catchment area behind Lebombo, viz., very old granites and sediments, with additions from the Lebombo basalts and rhyolites as well as from the sands of the coasts. The mud may rest on sand, while both are almost certainly underlain by Cretaceous sandy limestones and shales." (Dr. A. W. Rogers *in litt.*)

The mud supporting *Rhizophora mucronata* was sent by me to the Director of the Geological Survey of South Africa, and found to have the following rough composition:—

Above .1 mm. ... ..	66 per cent.
Above 0.1 mm. less than .1 mm. ...	27 per cent.
Soluble and clay grade, etc. ... ..	7 per cent.

There is quite a step between the sizes of the grains. The sand grade is on the average somewhat coarser than in the Riversdale sample, and the silt grade is approaching the clay grade in size being much finer than in the latter sample. The lime-content was 0.1 per cent.

The mud from the estuary of the Kafirkuils River, Riversdale, which supports *Spartina stricta* and *Arthrocnemum* spp., had the following composition:—

Above .1 mm. ... ..	48 per cent.
Above 0.1 mm. less than .1 mm. ...	49 per cent.
Soluble and clay, with a little floated off finer organic matter ... ..	3 per cent.

The sample had some quite large shells in it. The lime content was 3.70 per cent. in the complete sample, 4.40 per cent. in the sand grade and 1 per cent. in the silt grade.

That mangroves follow rather than cause silting is the view which is accepted by forestry authorities in the East Indies, Malaya, and the Philippines; but occasionally references in South African literature apparently suggest the contrary. *Rhizophoraceae* do not normally face the open sea-front, and when they do are able to

maintain only a precarious existence. The mangrove here is confined to the creeks, mouths of rivers, and their immediate neighbourhood. It comprises five species in all, belonging to *Rhizophoraceae*, *Verbenaceae*, and *Meliaceae*.

Seedlings of *Rhizophora* and pneumatophores of *Avicennia marina* are noticeable as the only growth on the outer mud flats. In this connection it may be noted that in the Federated Malay States species of *Avicennia* are pioneers on mud banks after silting has been brought about by the action of river and sea.

*Arthrocnemum indicum*, *Chenolea diffusa*, and *Suaeda maritima* are common, and *Sesuvium portulacastrum* grows not only on the muddy shores, but also on sand and in the *Pes*.

In some localities in the forest where the mud contains more sand, the same plants were found along with *Sporobolus virginicus*, *Dactyloctenium aegyptium*, and *Atriplex Halimus*. The level of these areas is often higher than their surroundings. Although not found abundantly, *Chrysodium aureum* occurs in situations of various degrees of salinity, both in wet and in fairly dry areas. *Derris trifoliata* is a creeping or twining shrub, with green sea-dispersed pods which are straw-coloured in the drift state, of the borders of the mangrove and swamps near the rivers. *Hibiscus tiliaceus* grows at higher levels and is in fruit, while *Thespesia populnea* was here a small tree or shrub five to eight feet high, in fruit and flower, on the sandy banks of the river especially at Matolla. *Caesalpinia crista* was growing on the outer landward mangrove border; but *Breria madagascariensis*, reported by J. Kirk from the mangrove further north, was not seen by me.

The mangrove forests here have been extensively exploited, and their height is not much above fifteen feet, but *Avicennia marina* is taller and often overtops the other species. The five local mangroves are as follows, and the measurements given apply only to trees from this neighbourhood:—

- (a) *Rhizophora mucronata*.—The trees are from 8 to 15 or in some cases 20 feet high. Sim states that this species produces pneumatophores, which is incorrect. It is gregarious, and occurs specially along the creeks, being inundated by normal high tides. The stilt-roots are larger and more numerous the nearer the tree is to the water. Seedlings grow on the mud flats, and are often mud-stained and encrusted with acorn barnacles.
- (b) *Bruguiera gymnorhiza*.—The trees are from 10-13 feet high, or sometimes a little more. It may associate with the preceding species, but occurs usually in less inundated areas. It bears knee-shaped respiratory roots.
- (c) *Avicennia marina*.—Under the erroneous name *A. officinalis* this is usually said to be in South East Africa a shrub 4 to 10 feet high. It may, however, exceed that height considerably. It occupies not only very wet areas but is plentiful further back in the drier landward parts of the forest. Pneumatophores 3 to 12 inches high are

emitted by cable-roots, which may be 75 to 100 yards long and often appear on mud among glassworts and on the drier site already mentioned.

- (d) *Ceriops tagal* (= *C. candolleana*).—This is here usually a shrub or a dwarf tree, 4 to 8 feet high, as compared with 80 feet in Malaya. It was bearing flowers and mature hypocotyls, the latter sticking in the mud or lying in thousands near the parent plants. The merest touch caused them to fall vertically, but when the branches were gently shaken many fell obliquely and lay horizontally on or at an angle to the ground. Others rested on soil so hard that they could not penetrate the surface, and in places where it was difficult to realize how they could be reached by inundation. It grows not only along the creeks, but is also thinly distributed in the drier landward and outer area along with *Avicennia*.
- (e) *Xylocarpus granatum*.—In spite of statements that this genus in East Africa extends only as far south as Quelimane, about 680 miles distant, the writer suspected the presence of a species near here owing to finding very fresh-looking unworn fruits and seeds thereof in the local seed-drift. Eventually he met with a single tree at Catembe, determined by Mr. John Hutchinson at Kew as *X. granatum*. It was growing in the rear of *Avicennia* in comparatively dry sand, was about 10 feet high, and bearing small, green, and some dry fruits. Later with Professor C. E. B. Bremekamp he saw a number of other trees of the same species along the Matolla River. Both tree and fruit are much smaller here than in the tropics.

In small areas bordering the narrow creeks the four first-mentioned mangroves were seen growing together.

Hypocotyls of the various species seemed sometimes to be lying in places where inundation and consequently dispersal by water are with difficulty conceivable. It is, however, possible that their buoyancy may enable them to take advantage of surface rain-wash after torrential down-pours. I have experimented with hypocotyls of *Ceriops*, the results confirming this in some degree.

#### *Epiphytes and Parasites in the Mangrove.*

Although neither so abundant nor so luxuriant as in the neighbouring coast forest, lichens occur here as they also do in the Natal mangrove. The writer found them mostly in the outer mangrove on *Ceriops*, *Rhizophora*, *Avicennia*, and *Bruguiera*. *Graphis scripta* and *Ramalina yemensis* occurred on the first two and were determined by Professor van der Byl. He found no mosses on trees in the mangrove swamps, and they are very rare in this situation in Indo-malaya. (Schimper *l.c.* 60).

*Viscum obovatum* was collected on *Ceriops*, and *Loranthus oleaefolius* var. *Forbesii* on *Rhizophoraceae*, both here and at Matolla. They obviously suggest the presence of fruit-eating birds.

*Animal Associates of the Mangrove.*



The following list is given for comparison with Schimper's account thereof in the Indo-malayan mangrove. Besides those already mentioned there are:—

1. Molluscs sessile on the roots:—*Ostrea cucullata*, *Tenebralia palustris*, and *Cerithidea decollata*, the last also at Durban. *Theodoris natalensis* in Durban Bay belongs to a genus which under the name *Neritina* is quoted by Schimper from the Malayan mangrove. *Nerita albicilla* is common at Lourenço Marques.
2. *Crustacea*.—Several species of crabs occur, including a *Sesarma* which is present also in Natal. This genus is represented in the Ceylon and Indo-malayan mangrove; also a fiddler-crab belonging to the genus *Uca* (*Gelasimus*). There is also a mud-inhabiting prawn. Certain crustaceans at Lourenço Marques make burrows, the entrances to which are surrounded by scrapings. This tends to raise the level of the forest floor, which is later colonized by *Suaeda*, *Sporobolus*, and other plants.
3. Ants.—*Occophylla smaragdina*, here as in the East Indies, stitches the living leaves of the mangrove together to form nests. It is almost certainly the same as one recorded, but not named, by Schimper. There are other species of ants present.
4. A butterfly (?) *Salamis*, and a moth (?) *Argema*.
5. Mosquitoes are not troublesome during winter. Lourenço Marques was formerly a bad malarial centre, but is now much better in this respect.
6. Fishes.—*Periophthalmos koelreuteri*, of which *P. schlosseri* of the East Indies is perhaps only a variety. It may be the same as that mentioned but not specified by Schimper. Other fishes in the mangrove belong to the genera *Salaria* and *Petroscirtes*; and *Gobius de-waali* is found in Natal.
7. Crocodiles frequent some of the swamps to the northwards.
8. Birds.—*Halcyon senegalensis*, the "Mangrove Kingfisher", is found from East London to Mombasa. *Phoenicopterus roseus*, *P. minor*, *Larus cirrhocephalus*, terns and other sea-birds are met with at times on the mud flats.
9. I saw goats feeding on *Sporobolus* and breaking off twigs and leaves of the mangroves, which they also eat if the statements of the native herdsmen may be believed.
10. Man.—The forests have long been exploited for firewood, poles, dyeing materials, and tannin. Fishermen here use the bark for tanning nets.

#### COMPARISON WITH THE MANGROVE OF OTHER AFRICAN STATIONS.

Meteorological statistics for Lourenço Marques and Durban are shown in Table III, and, although the stations at which they are compiled do not lie actually in the mangrove swamps, they afford nevertheless valuable indications.

TABLE III.

	Lourenço Marques.	Durban.
Mean Ann. Temp.....	71·6 F. (20 years).	70·30° F.
Mean Ann. Rain. ....	779·9 m.m.=30·7 in (20 years).	41·37 ins. (1873-1921).
Rain. June-August.....	5·2% (20 years).....	7·5%.
Mean Cloud.....	4·6	4·7.
Rel. Humidity.....	74·9 (20 years).....	76 for summer and 74 for winter months.

The figures for relative humidity at Durban are taken from the *S. & E. Afr. Yearbook*, 1926; the observations at Lourenço Marques were made at the Campos Rodrigues Observatory. The seasons are reversed when compared with those in the Northern Hemisphere.

Lourenço Marques is about 230 miles nearer the tropics to which all mangroves really belong. Apart from any influences of the warm current Lourenço Marques has a great point in its favour, namely the immensely larger sheltered areas of rich silt carried down by five rivers which enter the Bay.

At Durban there are three species of mangroves as compared with five at Lourenço Marques, the trees are not so luxuriant or area for area so abundant, and the mangrove and *Barringtonia* associates are fewer.

When Lourenço Marques is compared with the coast further north, the trees in the latter region are on the whole still more luxuriant, the forests more dense, and some essentially more tropical species appear, viz. *Lumnitzera racemosa* and *Sonneratia caseolaris*. A third tropical species, *Heritiera littoralis*, is met with at Inhambane, 284 miles north of Lourenço Marques.

The mangrove is, therefore, less developed on the warmer coasts of the Union of South Africa than at Lourenço Marques, less at the latter than in East Africa, and less in East Africa than in Indomalaya; but in all it is East Indian in type.

#### STRAND-PLANT MIGRATION ON THE EAST AND SOUTH COASTS.

There is evidence of a distant southern invasion of the temperate strand vegetation by a tropical element, but practically none by the temperate element in the reverse direction. There are, for example, comparatively few species which are common to the beaches west of Cape Agulhas and to Mocambique. The main warm southward-flowing surface current is an all important cause of strand-plant migration in that direction. Eventually, however, with other factors, it tends to limit it. Noteworthy features are also the increase from south to north in the number of species which are current-dispersed, in the extent of the consociates and associates, in the luxuriance of certain trees and other plants, and in the number of the associates of the mangrove and the *Barringtonia*.

## STRAND-PLANT MIGRATION ON THE WEST COAST.

Cold currents flowing from higher to lower latitudes, such as the Benguela and the Humboldt, act by diminishing rainfall and reducing temperature along the coasts of the adjoining continents. When the influences on the west are taken with those of the warm current on the east coast of Africa, the statistical differences between places in the same latitude, but on opposite sides of the continent, are very marked. Some of these are brought out by Table IV, the figures having been compiled from the works by Knox and by Martens and Karstedt, as well as from the *Official Handbook of the Union of South Africa*.

The 64th degree isotherm for the winter month of July, for example, intersects the coast line on the east near Durban in about 30 degrees S. Lat., but on the west near 22 S. Lat. In January, mid-summer, it lies altogether outside the coast on the east and south, and cuts the west coast at about 30 S. Lat. The same annual isotherm intersects the south coast at 33·58 S., and the west at about 29 S. On the west coast of South America there is a similar deviation of the isotherms northwards.

TABLE IV.

	Lat. S.	M.A.T.	M.A.R.
			Ins.
Banana.....	6·0	78·5 F.	27·2
Loanda.....	8·49	74·1	10·6
Lobito Bay.....	12·20	—	9·0
Walvis Bay.....	22·58	59·5	0·3-0·75
Port Nolloth.....	29·14	57·5	2·17
Capetown (Ob.).....	33·56	62·0	25·60
Cape Agulhas.....	34·50	61·5	16·94
Port Elizabeth.....	33·59	64·0	22·23
Port St. Johns.....	31·38	66·9	48·56
Durban.....	29·52	70·3	41·37
Lourenço Marques.....	25·58	71·6	30·70
Beira.....	19·49	75·6 (1)	37·0 (1)
Zanzibar.....	6·10	80·0	58·0

(1) *Lourenço Marques Directory*, 1930 (Manica, p. 6.).

At Mossamedes, in 15·10 Lat. S. on the west coast, the temperature in the hot season is about 86° F., while from June to September the thermometer frequently falls to 42° F. The annual rainfall is about one inch (Knox, *A. Climate of Continent of Africa*, 1911).

Around Pointe-Noire, in French Equatorial Africa, the coast is low and sandy and well-clothed with vegetation down to the beach. The climate of this region—Middle Congo—is of course equatorial, with a rainfall of from 40-100 inches abating with distance from the coast. (O. Martens & Dr. O. Karstedt, *African Handbook*, 1932, p. 774). I observed, during a walk of several miles along the beach, *Scaevola Plumieri*, *Canavalia obtusifolia*, and *Ipomoea* spp., growing

luxuriantly, and further back a *Sansevieria*. This strip of strand vegetation passes into scrub and *Cocos nucifera*, the latter cultivated. In creeks *Rhizophora racemosa*, *Drepanocarpus lunatus*, and other swamp species were present. The richness of the vegetation could partly be deduced from the abundance of the local seed-drift, which has been already described.

Near Banana at the mouth of the Congo the mangrove is enormously developed. This town is about ninety miles south of Pointe-Noire.

South of this again the Benguela Current takes leave of the coast, and the general aspect of the shore and its vegetation becomes very different. Before reaching St. Paul de Loanda the coast for a great distance is lined by high cliffs, which slope backwards at their summits to form hills covered with close grass, scattered low bushes, and occasional but not very tall trees. The shrubs are mostly collected into the more sheltered ravines. The coast while arid is not desert and there is a somewhat scanty vegetation. Far away in the distance could be seen the mountains of the inland plateau where conditions are very different.

On the sand-spit at Loanda *Casuarina equisetifolia* and *Cocos* grow very well. Where it joins the mainland a mangrove swamp existed in former times which has now been built over, but to the southwards on the Cuanza River such swamps are still present. In the beach-vegetation of this region the following plants, some of which have sea-dispersed seeds, may be found:—*Scacrola Plumieri*, *Canavalia obtusifolia*, *Ipomoea Pes-caprae*, *I. stolonifera*, *Cassytha filiformis*, *Frankenia pulverulenta*, *Cyperus maritimus*, etc.

After leaving Loanda the weather became decidedly cooler. There were still to be seen the same types of high cliffs, hillsides, and distant mountain ranges; still the low trees, and scanty shrubs aggregated into lines in the ravines.

Where the course of a torrent had cut through the cliffs to enter the sea, green masses of trees and other vegetation surrounded the mouth, which were so sharply marked off from the surrounding arid area as to look artificial and as if planted by man. The prevailing colour of the country at this time of the year—September—was brown, and the landscape showed the same covering of dry grass over which at Loanda I had had an opportunity of walking. That it was not too arid was proved by the presence of an occasional farm-dwelling, and while drier than around Loanda the general impression afforded was still much the same.

At Lobito Bay *Casuarina* and *Cocos* again appeared on a sand-spit forming the harbour, and there was still a distinct, albeit more scanty, beach vegetation.

From the latitude of Mossamedes there exists a true coast desert of rock and sand.

The meagre strand-vegetation of the South West African coast has been already considered.

The cold Benguela Current, by producing adverse climatic and coast-desert conditions, has caused the prevention or limitation of the southward migration of strand-plants. The mangroves such as

*Rhizophora racemosa*, *Laguncularia racemosa*, *Avicennia nitida*, and *Carapa procera*, reach southwards only to Angola. The lack of sufficient silt brought down by the mostly inadequate rivers has also militated against the full development of such vegetation.

A similar limitation of the southward distribution is seen in the cases of *Drepanocarpus lunatus*, *Entada gigas*, *Operculina tuberosa* Meisn., *Ximenia americana*, and other plants.

An enormous gap, therefore, especially in southern Angola and in the Namib, has been produced in the continuity of the distribution of a number of seashore and dune species. *Scaevola Plumieri*, for example, extends from Senegal in 16° Lat. N. to Benguela, which is 36 km. south of Lobito Bay, only to reappear on the south coast of the Cape Province. (It has been thought that this plant may have had its origin in West Africa).

The following species, among others, extend on the east and south coast of South Africa much more further southwards than they do on the west coast of Africa:—*Canavalia obtusifolia*, *Dodonaea viscosa*, *Cassytha filiformis*, *Hibiscus tiliaceus*, *Thespesia populnea*, *Entada gigas*, *Caesalpinia crista*, *Vigna luteola*, and *Ipomoea Pes-caprae*.

This applies not only to individual species, but also to different species of the same genus. Examples of this are *Avicennia marina* on the east and *A. nitida* on the west; also *Rhizophora mucronata* on the east and *R. racemosa* on the west.

It is true, moreover, of plants belonging to different genera of the same family, e.g. *Xylocarpus granatum* on the east and *Carapa procera* on the west coast.

*Ximenia americana* and *Gyrocarpus americanus* are both found in the interior but not in the strand vegetation of Angola. The positions occupied by these plants in general are given in the Synopsis.

Although stranded alien seeds in general have usually, even under favourable conditions, difficulty in gaining a footing, it is evident that on the desert and semi-desert areas of the west coast these difficulties are well-nigh insuperable. But in any case such drift-seeds do not seem to be plentiful there, and on much of that coast could in most cases arrive only by a very devious oceanic course.

#### COMPARISONS WITH CONDITIONS ON WEST COAST OF SOUTH AMERICA.

Climatic and other conditions on the west coast of South America, owing to the influence of the cold Humboldt or Peruvian Current, resemble in some respects those on much of the west coast of Africa. With regard to the littoral floras of the former Guppy distinguished four zones, but made no comparison with those of the latter. His account is here summarized, although the present writer does not desire to lay undue stress on some features which the vegetation of both may appear to possess in common:—

- (a) A *Convolvulus Soldanella* zone from 42 to 30° Lat. S., corresponding to watered and vegetated inland regions. It bears *Convolvulus Soldanella*, *Nolana* sp., *Polygonum mari-*

*timum*, *Salsola Kali*, *Selliera radicans*, *Armeria maritima*, *Senecio radicans*, *Salicornia* sp., *Samolus*, *Franseria*, and *Mesembrianthemum*. This may be compared with the South African region from the Cape to near the Olifants River. *C. Soldanella* occurs at Riversdale, and has probably elsewhere on our temperate coasts been sometimes overlooked. Some of the other plants named are also found on the South African west coast.

- (b) A plantless or desert zone, corresponding to the great desert of northern Chile and extending to 18°30' Lat. S. Very little seed-drift and few plants are found here. It may be compared with the Namib.
- (c) The *Sesuvium* zone from 18°30' to 3°30' Lat. S. with *Sesuvium portulacastrum*, *Heliotropium curassavicum*, *Salicornia*, *Suaeda fruticosa*, and *Batis maritima*.

From Mossamedes northwards the following occur:—*Heliotropium curassavicum*, *Sesuvium portulacastrum*, *Ipomoea Pes-caprae*, *I. stolonifera*, *Scaevola Plumieri*, *Suaeda fruticosa*, *Remirea maritima*, etc.

In the corresponding zones of both continents the littoral flora is scanty, the beaches line a region which though dry is not one of absolute aridity, and the amount of precipitation is low.

- (d) The Mangrove zone. This begins in both areas where the influence of the cold current weakens, and attains its full development after the current turns away from and leaves the coast. This zone extends in West Africa much further south than in west South America. In both it seems to be a species of *Avicennia* which comes furthest southwards.

Another point in common on the drier portions of both coasts is that the few strand-plants which do occur are concentrated chiefly about the estuaries and lagoons.

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## CHAPTER II.

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### SYNOPSIS OF THE STRAND FLORA.

Since the title of this chapter may be somewhat misleading a few explanations are necessary.

All plants have been recorded which, as far as the writer knows, have any pretensions to be regarded as true South and East African strand-species, but others have no such claims, and are only facultative seashore species or invaders. The list has been drawn up with special reference to the problem of oceanic seed-dispersal, and accordingly certain estuarine and river-bank plants with sea-dispersed seeds are included. In many or most cases these, however, grow in proximity to salt or brackish water. Further, where a species is mentioned as being sea-dispersed it is not in every case implied that this is the only method of dispersal.

The term "seed" is, as elsewhere in this paper, used to designate the unit of dispersal, and includes "the fruit", and even other parts.

Oceanic seed-dispersal in the Indian Ocean has occurred mainly in the direction from east to west, but in East and South Africa the direction has been from lower to higher latitudes. Comparison has been made, therefore, of the occurrence and distribution of strand-plants on the African or western shores of the Indian Ocean with their occurrence and distribution on its eastern shores, and more especially in the East Indies. As regards the latter the writer has relied largely on Dr. G. Booberg's revision of Schimper's Synopsis of Indo-malayan strand-species. All relevant material in the Kew Herbarium has been as far as possible carefully examined.

Reference has been made elsewhere to plants, many of which are common to the seashore and to inland saline areas on the margins of salt-pans. (Muir, J., *Vegetation of the Riversdale Area*, 1929, 28-29.) A few such plants have also been recorded from Soutpan, which is 30 miles north-west of Waterpoort in the Transvaal and some hundreds of miles from the coast, and from other inland localities. The plants found on the shores of the isolated salt-pans in the Riversdale Division, at a distance of twelve miles from the coast, are:—*Sporobolus virginicus*, *Spergularia marginata*, *Frankenia hirsuta* var. *Krebsii*, *Plantago carnosa*, *Chenolea diffusa*, *Psilocaulon parviflorum*, *Carpobrotus Muirii*, *Juncus* sp., *Chironia baccifera*, *Atriplex Halimus*, and *Salicornia* sp. All of these may quite well have been dispersed by limicole and other birds which frequent both regions in Riversdale, such as some species of *Charadrius*. *Numenius arquatus*, *Alopochen aegyptiaca*, *Anas undulata*, *Nyroca erythralma*, kingfishers, herons, and egrets. This dispersal is not of course always endozoic, but also by adhesion of mud.

(The abbreviation D.E.I. signifies Dutch East Indies.)

#### CYCADACEAE.

*Cycas Thouarsii* R. Br.: E. Afr. (Zambesi delta, Zanzibar, cultivated); Maur. (cultivated); Mad.; Comoro Is. In D.E.I. (Java), Nicobar Is., New Caledonia, etc., the strand-species is *C. Rumphii* Miq., and both species are sea-dispersed.

#### PANDANACEAE.

*Pandanus* spp.: Certain species occur on or near E. Afr. coast. Most species have a restricted distribution, all of the four found in Seychelles being endemic, and the Mascarenes have also their peculiar kinds. Portions of the air roots, but not the fruits, appear in S. Afr. drift. The species with a wide distribution are current-dispersed, e.g. *P. tectorius* Sol. var. *littoralis* Martelli (India to Pacific; not in Africa), which is the most common one in Java.

#### POTAMOGETONACEAE.

*Zostera marina* L. var. *angustifolia* Hornem.: S. Afr.; Eur.; N. Afr.; E. Asia; N. Amer. Portions of rootstock are sea-dispersed.

*Z. nana* Roth.: S., N. & W. Afr.; Mad.; Eur.

*Ruppia spiralis* Hartm.: S., N. & W. Afr.; Eur. Regarding *R. maritima* L. as including this, it may be said to occur in brackish water over most of the world.

*Zannichetia palustris* L.: S. Afr. (Namaqualand to Natal in brackish localities which have now lost all connection with the sea (E. L. Stephens), and far inland in isolated freshwater pools); Mad.: N. Afr.; India; Amer., etc.

*Althenia austro-africana* Schönk.: S. Afr. (Uitenhage): brackish water.

*Chymodocca isoetifolia* Ashers., a marine plant, is found from E. Afr. to the Pacific; and *C. serrulata* Ashers. & Magn., also marine, from E. Afr. to N. Austr. and New Cal.

#### SCHEUCHZERIAACEAE.

*Triglochin striatum* Ruiz & Pavon.: S. Afr. [in both brackish and freshwater localities in Cape; Pondoland in association with *Bruguiera* (Muir); Natal; and inland].

*T. laxiflorum* Guss.: S. Afr. (Cape; Natal, in halosere).

#### HYDROCHARITACEAE.

*Halophila* sp: S. Afr. (Port Alfred, among glassworts).

*Enhalus aceroides* (L.f.) L. C. Rich.: a marine plant, Seych.: Mad.; Indo-mal.; N. Austr.; W. Pac. Is. In Dutch East Indies (Booberg).

#### GRAMINEAE.

*Perotis indica* (L.) O.K.: S. Afr. (Natal, from coast inland to over 1,000 ft. above sea-level; Transvaal, far inland; S. W. Afr. inland, "a good cattle fodder"); P. E. Afr. (Delagoa Bay); tropics of Asia, Austr., Amer., and Afr. More essentially a seashore sp. in some other countries; in Dutch East Indies on sandy strand to 30 feet above sea-level.

*Sporobolus virginicus* Kunth: S. Afr. (all round coast, a beach pioneer and often the plant nearest the waves, by which it may be inundated; inland salt-pans: on many warmer and tropic shores. Java

*Stenotaphrum secundatum* O.K.: S. Afr. (common on upper-beaches where soil not too saline, Cape Town to Natal); W. Afr. (Sierra Leone to Angola); N. & S. Amer. (Atlantic coast from S. Carolina to La Plata); St. Helena; Pacific (S. Mexico to Austr.); Polynesia. Common inland. Not known from Dutch East Indies (Booberg).

*S. dimidiatum* Brongn. is found at Zanzibar; Pemba P.E. Afr.; Mad. and its islands; Seych.; Masc.; Ceylon; India.

*S. subulatum* Trin. occurs in Seych.; Masc.; Galega Is.; Aldabra; Queensland; N. Z.; Polynesia. These localities are taken from the sheets at Kew.

*Thuarea involuta* R. & S.: Mad. to Austr. & Pacific. Fruit found in drift of Kaw Tao Island off Siamese coast (A. F. G. Ker); common on sandy seashore in Dutch East Indies. May be partly sea-dispersed.



- Dactyloctenium aegyptium* (L.) Beauv.: S. Afr. (an annual weed-like plant on upper-beach and, more usually, on landward side of dunes). Beauvois is the author of this species, which was noted on the sheets at Kew from Kentani, Pondoland, Durban, and Delagoa Bay.
- D. geminatum* Hackel: a perennial also found at Delagoa Bay; Beira, Malotta; and N. to Italian Somaliland.
- Agropyrum distichum* Beauv.: S. Afr. (S. W. Afr. to Port Elizabeth, etc., on seashore dunes, and in saline marshes, sometimes even standing in sea-water).
- Spartina stricta* (Ait.) Roth: S. Afr. (Riversdale, Port Elizabeth). Mr. Hubbard reports that Riversdale specimens have longer spikelets than those from Europe, which may be due to habitat; or they may be a distinct variety. The name *S. maritima* (Curt.) Fernald should not be used for that given above, as *Dactylis maritima* Curtis, on which it is based, is a superfluous name for *Dactylis cynosuroides* L.
- Ammophila arenaria* (L.) Link: a dune-plant planted and used as a sand-stayer on coast. (*Psamma* Beauv.)
- Eragrostis cyperoides* Beauv.: S. Afr. (S. W. Afr. to Cape, etc.): a dune-plant but may reach the upper-beach.
- E. glabrata* Nees: S. Afr. (sandy upper-beach and dunes, Cape Town, Somerset Strand, etc.).
- Lepturus repens* (Forst.) R.Br.: E. Afr. to Pacific on the seashore. Common on sandy shores in Java. (*Monerma repens* Beauv.)
- L. cylindricus* Trin.: S. Afr. (an introduced ruderal widely distributed inland). In many countries it is a strand-plant, but occurs also inland as a fodder grass widely introduced.
- Paspalum vaginatum* Nees (*P. distichum* L.): S. Afr. (seashore at Camps Bay; coast marshes in Natal); E. & W. Afr.; Mad.; Masc. to Pacific, etc. A tidal-mud grass, which may be dispersed by sea, floating logs and pumice, and by feet of birds.
- Ehrharta gigantea* has been much used on the mobile coast-dunes at Riversdale for reclamation purposes, and grows well there and elsewhere near the coast.

## CYPERACEAE.

- Cyperus maritimus* Poir.: P. E. Afr. (Lourenço Marques with *Scaevola*, etc. Muir 4792!); N. to Somaliland; Mad.; W. Afr. (Senegal to Loanda). All sheets examined at Kew.
- C. natalensis* Hochst.: S. Afr. (occurs with *Scaevola* on the coast of Natal and in P. E. Afr.; also in marshy places, and inland).
- Mariscus dregeanus* Kunth: S. Afr. (Transkei to Lourenço Marques; often in coast vleis of low salinity, and inland up to 2,000 feet; in Natal in vleis in the Midlands; Transvaal, inland). Found on the sandy seashore and in islands, possibly sea-dispersed. Trop. Afr.; Seych.; Masc.; India; Malay Peninsula to Borneo. Apparently in Java, but rare.

*M. pennatus* (Lamk.) Merr.: E. Afr. to Pacific and in most of the tropics, except W. Afr., in damp places on shore where the watery medium is salt, brackish, or fresh. Possibly sea-dispersed. Found in Dutch East Indies (= *Cyperus pennatus* Lamk.)

*M. maritimus* C.B. Cl.: B. E. Afr. on shore. I found no sheet of this at Kew.

*M. congestus* Vahl occurs in a maritime form with *Scacvola Plumieri* and *Ipomoea Pes-caprae* at East London and Port St. Johns. The species itself is the most widely distributed sedge in S. Afr. and also occurs inland up to 4,500 feet.

*Juncellus lacrigatus* C.B. Cl.: S. Afr. (Swakop Mund & Walvis Bay to P. E. Afr., on dunes, moist sandy shores, sometimes standing in sea-water, and inland up to 4,000 feet). In all warm and temperate regions.

*Scirpus maritimus* L.: S. Afr. mostly in fresh-water marshes or dry vleis in non-saline localities. Found inland up to 2,500 feet. In Great Britain it occurs in salt marshes (Hooker, J. D.) In most extra-tropical regions, but unknown from Dutch East Indies. Fruits buoyant.

*S. littoralis* Schrad.: S. Afr. (Little Namaqualand near mouth of Orange River; Cape in vleis; Natal in salt marshes and swamps near the mouths of rivers).

*Ficinia lateralis* Kunth: S. Afr. (seashore, rocks, and dunes, Cape Town to Koumgha, and inland up to 2,000 feet). (= *F. aphylla* Nees).

*Fimbristylis obtusifolia* Kunth: S. Afr. (Pondoland and Natal near salt or brackish water, often at mouths of rivers); P.E. Afr. (Delagoa Bay); Trop. Afr.; Masc., etc.

*F. ferruginea* Vahl: S. Afr. (coast about mouths of rivers, and also inland, and not markedly a strand-plant). In Java and much of the tropics it is a strand halophytic species.

#### PALMAE.

*Cocos nucifera* L: P.E. Afr., etc. (cultivated on strand, dunes and inland). Widely in tropics.

None of the South African palms is a true strand species, but *Jubaeopsis caffra* Becc. comes nearest to being one as it grows at the mouths of the Umsikaba and Umtentu Rivers, Pondoland, close to the water's edge. Fruits of this, several years old, were tested for buoyancy, but did not float. *Raphia vinifera* Beauv. (N.E. Zululand, Moçambique, Nyassaland, etc.) is not a beach-plant, and the fruits, although found at Riversdale to be buoyant, are not effectively sea-dispersed. *Hyphaene crinita* Gaertn. is very common in the coast-belt of Natal, Zululand, and northwards, on drift sands behind the line of the coast dunes, and also in the tree-veld of that belt. The fruits are very plentiful in the beachdrift of Natal and Moçambique; and I found, similarly, those of *H. thebaica* in the beach-drift of French Equatorial Africa on the West Coast

of Africa; *Phoenix reclinata* Jacq. is frequent in the coast-scrub and tree-veld of the coast-belt from near Algoa Bay, eastwards.

Similarly of nine species of palms found in the Seychelles, six of them endemic, none, even *Lodoicea maldivica*, is a strand-plant, although the fruits of the last-named are transported by ocean currents far and wide across the Indian Ocean.

#### FLAGELLARIACEAE.

*Flagellaria indica* L. var. *guineensis* (Schum.) Engl.: I have seen this mainly in coast scrub of Pondoland, and it occurs in Natal and Trop. Afr., but it is not a true strand-plant. *F. indica* L. ranges from the Mascarenes to the Pacific, and in the D.E.I. is found on the strand and inland to 2,600 feet.

#### JUNCACEAE.

*Juncus maritimus* Lan.: S. Afr. (common on the outer border of the halosere as well as in fresh-water localities; inland up to 5,000 feet); Eur. (salt marshes, etc.); widely dispersed in Old and New Worlds.

#### LILIACEAE.

*Anthericum revolutum* L.: S. Afr. (Cape to Port Elizabeth on sandy beaches, dunes, and inland up to 1,250 feet). The dry inflorescences are blown about by the wind; seeds non-buoyant.

*Asparagus* sp.: S. Afr. (East London on seashore and dunes).

*A. Capensis* L. is sometimes found on the upper-beach, also on shingle, and rocks on the shore. It occurs more usually inland, ascending to 5,000 feet above sea-level.

#### TACCAEAE.

*Tacca leontopetaloides* O.K.: not found wild in S. Africa: cultivated extensively in tropics, and thus extends often far inland. In some countries a strand-plant. Seeds current-dispersed. In the Dutch East Indies it occurs on the strand in the *Barringtonia*, and inland up to 160 feet above sea-level. In N. Rhodesia; E. Afr; Seych. to Indo-malaya and Pacific.

#### IRIDACEAE.

*Acidanthera brevicollis* Baker: S. Afr. (Bathurst to Natal on sandy beaches). Partly sea-dispersed by bulbils.

#### ORCHIDACEAE.

*Disperis stenoglossa* Schltr.: S. Afr. (a coast halophyte in Natal (Bews), in marshes near Durban at 10 feet above sea-level).

#### CASUARINACEAE.

*Casuarina equisetifolia* L.: S. Afr. (widely cultivated; E. Afr. (introduced; a strand species in Indo-malaya (including Java); Austr.; Philipp. to Pacific. Widely cultivated on coasts and inland in warmer countries.

## MYRICACEAE.

*Myrica cordifolia* L.: S. Afr. (sea-shore on sand and rocks, and on dunes, Cape to East London).

## SANTALACEAE.

*Osyris abyssinica* Hochst.: S. Afr. [Cape to Natal on upper-beach (rarely), on dunes with *Scaevola* (frequently), and widely distributed inland up to 4,000 feet: fruits eaten by birds, stock, other animals, and man.]; Trop. Afr.

*Thesidium fragile* Sond. is parasitic on shrubs on the upper-beach, but is commoner on the dunes.

## LORANTHACEAE.

*Viscum capense* L.f. may occur on shrubs bordering the upper-beach. *V. obovatum* Harv. and *Loranthus oleaefolius* C. & S. var. *Forbesii* Sprague are found on mangrove spp. at Delagoa Bay. They do not, however, belong to the strand vegetation. *Viscum articulatum* Burm. and *V. orientale* Willd. (neither of them found in South Africa), and others of the family, are parasites found in Java in the strand vegetation and inland.

## OLACACEAE.

*Ximenia americana* L.

Dr. H. G. Schweickerdt, who has specially studied the South African species, is of the opinion that true *X. americana* L. does not occur in South Africa.

The distribution taken from the sheets at Kew is:—E. Afr. (Kenya up to 6,000 feet: Tanganyika up to 4,500 feet); N.E. Afr. (Abyssinia and Soudan, inland); Cent. Afr. (Uganda); Seych. (near the sea); not found in the Mascarenes; W. Afr. (Sierra Leone; Senegal; Togo; Gold Coast; N. & S. Nigeria; Lagos; Cameroons; French Guinea; Angola; in West Africa common in savannah region, but also near the coast); British India (W. Peninsula, Madras); Ceylon; Andamans; Malaya (Malay Peninsula, in Java exclusively on the strand in the *Barringtonia*); Austr.; Pacific (Samoa, Marianne Is.); Florida (interior); W. Ind. (Jamaica, where it is characteristic of interior); Cent. Amer.; east trop. S. Amer., etc. The fruits are sea-dispersed but are also disseminated by man, birds, bats, and monkeys.

## POLYGONACEAE.

*Polygonum maritimum* L.: S. Afr. (Lambert's Bay and Camp's Bay on the sandy beach); N. Afr.; Azores; Eur.; W. Asia; N. Amer.

## CHENOPODIACEAE.

*Chenolea diffusa* Thunb.: S. Afr. (all round coast on rock, shingle, sand, and in damp places on the borders of marshes; also inland on salt-pans, etc.).

*Salsola Kali* L.: S. Afr. (coast and far inland); Eur.; N. & S. Amer.; Austr.; Tibet; Indo-mal. (Java, etc., on sandy strand, not common).

*S. Zeyheri* Schinz is an inland and dune, not a strand, species (S.W. Afr., Namaqualand, etc.); Trop, Afr.

*Atriplex Halimus* L.: S. Afr. (Riversdale on the upper-beach; Lourenço Marques on the border of the mangrove swamps; also inland); Eur.; N. Afr., etc.

*A. littoralis* L., *A. laciniata* L., and *A. portulacoides* Gmel., which in Great Britain occur largely in salt marshes, are found also in South Africa, where their localities and habitats have been insufficiently recorded.

*Suaeda maritima* (L.) Dum.: S. Afr. (Lüderitz, Port Elizabeth, Bathurst, Lourenço Marques). In Java on strand and other open tracts on damp, saline, clayey soil. At Lourenço Marques the habitat also contains clay.

*Arthrocnemum indicum* Moq.: P. E. Afr. (Lourenço Marques on saline mud flats and border of the mangrove); widely distributed around Indian Ocean; in Java and neighbouring smaller islands.

I am greatly indebted to the late Professor C. E. Moss for naming my own collections, but I have no knowledge of some of the other species found on our coasts. He hoped to have published an account of the genera and species during 1925 (*in litt.* 24.7.1924). The species of the Riversdale and adjoining districts are:—*A. litoreum* Moss (= *Salicornia fruticosa* of *Flora Capensis*, non. L.); *A. natalense* (Bunge) Moss; *A. variiflorum*, Moss; *A. africanum* Moss (= *Salicornia natalensis* C. H. Wright non Bunge); and *Salicornia meyeriana* Moss (= *S. herbacea* C. H. Wright non L.)

Professor Moss is the real pioneer in the study of this genus as far as South Africa is concerned, most species having previously either been unrecognized or imperfectly understood.

#### AMARANTACEAE.

*Achyranthes aspera* L.: S. Afr. (a widely dispersed ruderal, and not specially a strand-plant). In Java a universal strand-species, and inland to 3,900 feet. Pan-tropical.

#### NYCTAGINACEAE.

*Boerhaavia diffusa* L.: S. Afr. (Natal, Transvaal, and Delagoa Bay, coasts to inland). In Dutch East Indies a very general plant of the sandy strand, and an inland weed.

#### AIZOACEAE.

*Sesuvium portulacastrum* L.: P. E. Afr. (in sandy and clayey places near Lourenço Marques); W. Afr. (Senegambia to Mossamedes); Ceylon; Keelings; Malaya (very general in Java) to Austr. and Pacific; W. Afr., etc.

*Carpobrotus edulis* N.E. Br.: S. Afr. (beach, dunes, and inland). *C. Muirii* and *C. acinaciformis* may occur on upper beach, but are more often found on dunes and inland.

*Disphyma crassifolium* N.E. Br.: S. Afr. (sandy beaches within reach of tide, on rocks, and inland).

*Cryophytum Aitoni* N.E. Br.: S. Afr. (seashores, dunes, and inland).

*C. crystallinum* N.E. Br.: S. Afr. (seashores, often within reach of spray, dunes, and further inland); introduced in S. Eur.; Canaries; California; Australia, etc.

*Tetragonia decumbens* Mill.: S. Afr. (seashore, dunes, coastal bush, etc., Cape to Kentani).

*Drosanthemum* spp.: various species occur at Lamberts Bay, Cape, Bredasdorp, Riversdale, and Port Elizabeth; but the writer's collections are as yet undetermined; mostly on rocks but sometimes on sand.

Other species of this family occur on the older portions of the beach, but are not obligate strand-plants:—*Cephalophyllum maritimum*, *Lampranthus diutinus* (upper-beach, dunes, and limestone rocks); *Galenia spathulata*; *Conicosia Muirii* *Delosperma litorale* (rocks on coast, dunes, and inland on limestone hills); *Dorotheanthus Muirii* (occasionally very close to high tide level); *Tetragonia fruticosa*.

#### CARYOPHYLLACEAE.

*Silene primulaeflora* E. & Z.: S. Afr. (upper-beach and dunes, west coast of Cape Prov. to East London).

*Spergularia media* Presl: S. Afr. (west coast of Cape Province to Port Elizabeth and Natal); N. Afr.; Eur.; N. & W. Asia; Austr., etc.: on sandy shores and in saline marshes chiefly, but also on inland salt-pans.

*S. rubra* Pers.: S. Afr. (west coast to Port Elizabeth, mainly in sandy and gravelly places); N. Afr.; N. & W. Asia to India; Austr.

#### LAURACEAE.

*Cassytha filiformis* L.: S. Afr. (Pondoland to P. E. Afr.); E. & W. Afr. (south to Angola); Seych.; Mad., etc.; pan-tropical. Very general in Dutch East Indies on strand, and inland to over 1,600 feet above sea-level. Dispersed by currents.

#### HERNANDIACEAE.

*Hernandia peltata* Meissn.: E. Afr.; Mad.; Masc. to Pacific. In Dutch East Indies on strand. Current-dispersed.

*Gyrocarpus americanus* Jacq.: S. Afr. (S. W. Afr.: N. Transvaal, Rhodesia, all inland); E. & W. Afr.: India; Malaya to Pacific, etc. Sometimes on coast near the sea, but often on the banks of rivers inland. Dispersed by wind, rivers, and sea. In Java rare, and found on strand and behind it, as well as inland.

#### CRUCIFERAE.

*Heliphila scandens* Haw.; S. Afr. (Natal, a halophyte of the upper-beach and on dunes). Another species, with broad succulent leaves, is common in the same situations on the Riversdale coast.

#### ROSACEAE.

Several species of *Griethum* occur on the foremost dunes and inland saline areas. *Chrysobalanus orbicularis* Schum. & Thonn. is a beach-plant in W. Afr. (south to Angola).

## PAPILIONACEAE. (FABACEAE).

- Canavalia obtusifolia* DC.: S. Afr. (East London northwards, mostly on dunes); E. & W. Afr.; D.E.I. (universal on sandy strand); pantropical. Seeds sea-dispersed. (= *C. maritima* Thou. & *C. rosea* DC.)
- C. bonariensis* Lindl.: S. Afr. (Pondoland, Natal, on upper-beach and dunes: introduced); S. Amer. (Brazil, Uruguay). Seeds sea-dispersed, probably also I think in ballast.
- Dendrolobium umbellatum* W. & A.: E. Afr. (Zanzibar, forming dense strands just above high water mark); Seych.; Mad.; Masc. to Pacific; D.E.I. (in non-marshy places). Pods sea-dispersed. (= *Desmodium umbellatum* DC.)
- Desmodium heterocarpum* DC.: E. Afr. (Zanzibar); Seych.; Masc. to Pacific; also inland. A littoral plant in Seych. (V. S. Summerhayes).
- D. triflorum* DC.: E. & W. Afr.; Seych.; and pantropical. Not given as a littoral plant in Seych. by Summerhayes; but in D.E.I. it is fairly frequent on the sandy strand, and inland to about 4,200 feet.
- Derris trifoliata* Lour.: P. E. Afr. (Lourenço Marques); W. & E. Afr. to Pac.; D.E.I. (universal in marshy places near sea). Pods and, to some extent, the seeds sea-dispersed. (= *D. uliginosa* Benth.)
- Abrus precatorius* L.: S. Afr. (often on dunes near sea; and inland). Not seen by writer on strand in S.E., E., or W. Afr. In D.E.I. sometimes near the strand. Not sea-dispersed.
- Erythrina variegata* L. var. *orientalis* Merr.: S. Afr. (introduced); tropics of Old World except Africa, but also widely cultivated. Seeds sea-dispersed. (= *E. indica* Lamk.)
- E. fusca* Lour.: E. Afr. (Pemba, probably introduced by man); Comoros; Ceylon; Malaya (but not a strand-plant in D.E.I.); a river-bank rather than a seashore species. Wrongly regarded as a shore or littoral species by Guppy. (*N.P.* II. 577). Seeds sea-dispersed. (= *E. ovalifolia* Roxb.)
- Indigofera tomentosa* E. & Z.: S. Afr. (a species which has been so named is frequent on upper-beach at Riversdale). Seeds not buoyant.
- Alysicarpus nummularifolius* DC.: E. & W. Afr.; India; Seych.; Malaya (in D.E.I. very general on sandy strand, and also inland to about 2,900 feet). (= *A. vaginalis* DC.)
- Dioclea reflexa* Hook. f.: Mad.; Indo-mal.; Philipp.; W. Afr. (Liberia to Angola); W. Ind.; S. Amer.: a river-bank and estuarine species with sea-dispersed seeds. (= *D. javanica* Benth.)
- Mucuna gigantea* D.C.: P.E. Afr. (Inkomati R. wild); Pemba (cultivated); Seych.; Mad.; Masc.; India; Ceylon; Andamans; Malaya (in D.E.I. general but only on strand or its vicinity); Philipp. to Pacific. In P.E. Afr. an estuarine climber in the *Barringtonia*, not on beach. Seeds sea-dispersed.

- Pongamia pinnata* Merr.: Masc.; India; Malaya (in Java universal on strand especially where sandy) to Pacific. Pods sea-dispersed. (= *P. glabra* Vent).
- Psoralea bracteata* L. var. *algoensis* (E. & Z.): S. Afr. (Riversdale to Bathurst, prostrate on upper-beach and behind it).
- Sophora tomentosa* L.: P.E. Afr. (on sandy shores often underlain by coral); E. Afr. to Pacific. In D.E.I. common on the non-marshy strand with high lime content. Seeds sea-dispersed.
- Strongylodon ruber* Vogel: a river-bank climber of Ceylon (very rare); Andamans; Philipp. (very rare); Pacific (Fiji, Hawaii, Tahiti). Seeds widely dispersed by sea. (= *S. lucidus* Seem.)
- Sutherlandia frutescens* R.Br. var. *tomentosa* (E. & Z.); S. Afr. (Cape, Riversdale, etc., on dunes and only rarely reaching the upper-beach). Bladdery fruits are dispersed by the wind, but not effectively by the sea, although they possess some buoyancy.
- Tephrosia canescens* E. Mey.: S. Afr. (Pondoland to Lourenço Marques with *Scacrola*, and in the "Pes".)
- Vigna marina* (Burm.) Merr.: S. Afr. (Pondoland, Natal, rare); E. Afr. (Rovuma Bay); Seych. to Pacific. In D.E.I. universal on the sandy strand. (= *V. lutea* Gray; *V. retusa* Walp.)
- V. luteola* (Jacq.) Benth.: S. Afr. (Uitenhage to Natal); E. & W. Afr.; Mad.; and many warm coasts. Considered by some botanists to be conspecific with *V. marina*, but by others kept distinct. Seeds of both are sea-dispersed.

## CAESALPINIACEAE.

- Caesalpinia cris.* L.: P.E. Afr. (Lourenço Marques); E. Afr.; Masc., etc. Pantropical on sea coast. Inland in Uganda and Himalayas. In D.E.I. (behind the foremost low sandy ridge of sand near sea, which is also its position in P.E. Afr.) Seeds sea-dispersed. (= *C. Bonducella* Flem.)
- Intsia bijuga* O.K.: Mad.; Seych.; Chagos Arch.; Galega Is.; Indo-malaya (in D.E.I. fairly common but only on strand); Andamans; Philipp. to Pac. Seeds sea-dispersed. (= *Azelia bijuga* A. Gray.

## MIMOSACEAE.

- Entada gigas* Fawc. & Rendle: S. Afr. (Zululand); P.E. Afr. (Lourenço Marques); E. & W. Afr.; W. Ind.; Trop. Amer. etc. *E. gigas* (L.) Fawc. & Rendle is the name given by these authors in their *Flora of Jamaica*, and adopted by Hutchinson & Dalziel in their *Flora of West Tropical Africa*. *E. scandens* Benth. is regarded as a synonym for this. In 1914 Merrill proposed the name *E. phasecoloides*, giving the species a pantropic distribution, and using it in the same wide sense as Linnaeus and Bentham did for their *Mimosa scandens* and *Entada scandens* respectively. It has, however, been suggested that *E. scandens* is a mixture of species. The synonymy and distribution of the various species or forms require further investigation. (Craib, W. G. *Florae Siamensis Enum.*, 1931, 542.) Seeds sea-dispersed.



*Acacia farnesiana* Willd.: S. Afr. (cultivated); E. Afr.; Seych.; Mad.; Masc.; Malaya (in D.E.I. fairly common on strand, and inland to 5,000 feet). Widely introduced in cultivation. Pods, but not the seeds, are sea-dispersed.

[NOTE.—*Pseudocadia zambesiaca* is a large tree, plentiful on the banks of the Limpopo and Sand Rivers and other water-courses of the northern and north-western portions of the region of sub-tropical evergreen and deciduous tree and thorn forest. (Dr. I. B. Pole-Evans; *A Vegetation Map of S. Africa*, Bot. Sur. of S. Afr., Mem. 15, p. 10). A number of the pods, which are one-seeded, were kindly supplied by Dr. Pole-Evans, and were found along with the contained seed to float at Riversdale for 4 to 5 days. The seeds, however, showed no separate buoyancy and sank instantly. The fruits and seeds behave much like those of *Dialium Schlechteri*, and have not been found in the beach-drift. Certain coast-scrub leguminous plants, e.g. *Bauhinia tomentosa* L., *Glycine javanica* L., and *Dalbergia obovata* E. Meyer, have fruits which are buoyant when tested, but they do not apparently owe their dispersal to the sea.]

#### GERANIACEAE.

*Erodium malachoides* Willd.: S. Afr. (Cape Pen., sandy beach, dunes, and inland); Eur.; N. Afr.; Canary Is.; S. Amer. (Peru).

#### ZYGOPHYLLACEAE.

*Zygophyllum Morgsana* L.: S. Afr. (Namaqualand to Port Elizabeth on dunes and inland; occasionally on upper-beach).

[*Balanites Maughamii* is a tree of the sub-tropical evergreen and deciduous tree and thorn forest, which covers parts of Zululand, Swaziland, and the Transvaal. (Dr. I. B. Pole-Evans; *A Vegetation Map of S. Africa*, Bot. Surv. of S. Afr., Mem. 15, p. 10). I have not found fruits in the beach-drift, and it is not sea-dispersed.]

#### SIMARUBACEAE.

*Suriana maritima* L.: P.E. Afr. (in littoral scrub, on sand and rock); E. Afr. to Pac.; unknown from D.E.I. Sea-dispersed, also by floating logs, etc.

#### MELIACEAE.

*Xylocarpus granatum* Koen: P.E. Afr. [Lourenço Marques (Muir 4089), Luabo R., Zambezi R. mouth, Savana, common in tidal waters]; Kenya in Pemba, Seych. to Malaya (D.E.I., almost exclusively in mangrove), Philipp., and New Cal. Seeds sea-dispersed.

*X. moluccensis* (Lamk.) Roem.: Kenya (Pemba, Mombasa); Seych. to Malaya (D.E.I., in *Rhizophora* forests in muddy or sandy ground periodically inundated by the tide) and Pac. Seeds sea-dispersed.

#### EUPHORBIACEAE.

*Euphorbia livida* E. Mey.: S. Afr. (East London to Natal, a perennial halophyte decumbent or prostrate on the seashore).

The following, although they are sometimes found on the upper-beach, and occur often not far from the sea, are rather dune- and not true strand-plants:—*Mundia spinosa* DC. (*Polygalaceae*); *Rhus crenata* Thunb. (*Anacardiaceae*); *Cassine maritima* L. Bol., *Maurocenia frangularia* Mill., and *Gymnosporia procumbens* Loes. (*Celastraceae*). *Mundia* and *Maurocenia* are found also far inland.

*Azima tetraantha* Lamk. (*Salvadoraceae*) is a coastscrub shrub, which on the Riversdale coast may occur within reach of the sea-spray, and at Lourenço Marques is found sometimes just outside the mangrove border and on the dunes near the sea. It is scarcely a strand-plant, and is met with also in E. Afr.; Uganda; W. Afr.; and Trop. Asia.

#### SAPINDACEAE.

*Dodonaea viscosa* L.: S. Afr. (Natal, dunes, coastscrub, and inland; also widely cultivated. Although found near sea it is not usually met with on the beach). P.E. Afr.; Seych. (a littoral plant, the variety *vulgaris* Benth.); Masc.; and in tropics and sub-tropics generally. In D.E.I. a non-pubescent form is very general on the sandy strand, a pubescent form growing inland to 6,500 feet. Possibly *D. viscosa* L. includes more than one species. Dispersed by the wind, and to some extent by the sea.

*Cardiospermum Halicacabum* L.: S. Afr. (Kei River mouth to Natal) is a coastscrub species. In D.E.I. it is not a strand-plant. Pantropical. In some other countries it occurs on the seashore and coral beaches.

#### RHAMNACEAE.

*Colubrina asiatica* (L.) Brongn.: P.E. Afr. (near Lourenço Marques, etc. on the sandy strand); Seych. to Pacific; W. Ind.; and inland. Fairly common in Java and surrounding islands. Seeds sea-dispersed.

*Phyllica microphylla* Dietr. var. *maritima* Pillans: S. Afr. (S.W. districts of Cape on upper-beach and dunes).

#### MALVACEAE.

*Hibiscus tiliaceus* L.: S. Afr. (East London to Delagoa Bay, on tidal creeks near the sea); E. Afr. to Pacific and on all tropic and sub-tropic coasts. In D.E.I. very common in the *Barringtonia*, which is also partly the habitat on the Inkomati R. in P.E. Afr. Seeds sea-dispersed.

*H. diversifolius* Jacq.: S. Afr. (not a strand-species); P.E. Afr.; Mad.; Masc. to Pacific. A littoral plant in Fiji. Seeds buoyant, but probably not sea-dispersed.

*Thespesia populnea* Sol.: S. Afr. (Zululand); P.E. Afr. (mostly on banks of tidal rivers further away from water than the mangrove); E. Afr.; Seych.; and many tropical and sub-tropical coasts of the Old World; also in W. Ind. In Java on the border of the *Barringtonia* or in the neighbourhood of the sea. In Malay Pen. on sandy beaches. Seeds sea-dispersed.

*Sida cordifolia* L. is a fibrous shrub common near the outer margin of the coastscrub in Natal. In D.E.I. it occurs exclusively on the strand or on the dunes behind. Common in the tropics.

## FILIACEAE.

*Triumfetta repens* (Bl.) Merr. & Rolfe: Seych.; Keelings; Java; Islands in Gulf of Siam; off Cambodia; Borneo; off coast of Queensland; Philipp. Is. Sea-dispersed, or by birds by adhesion.

*T. procumbens* Forst.: Amirante Is. (des Roches); Providence Is.; Galega Is.; Chagos Arch.; not reported from Seychelles (Summerhayes); not known from Java; also found in New Guinea; Queensland; Polynesia (Friendly, Ellice, Tonga, Samoa, and Cook's). Dispersed by sea, possibly by adhesion to plumage of birds, or on floating pumice.

## STERCULIACEAE.

*Heritiera littoralis* Ait.: P.E. Afr. (Inhambane northwards); E. Afr.; Seych.; Masc.; Malaya (including D.E.I.) to Pacific. Sea-dispersed.

## GUTTIFERAE.

*Calophyllum inophyllum* L.: E. Afr. (Mozambique, Zanzibar, Pemba, introduced); W. Afr. (Gold Coast, Nigeria, introduced); Seych.; D.E.I. (on sandy and rocky strand); extends to Pacific. Sea-dispersed.

## FRANKENIACEAE.

*Frankenia hirsuta* L.: S. Afr. (var. *laevis* is more common. The var. *Krebsii* occurs at Uitenhage, etc., and on shores of inland salt-pans in Riversdale.

*F. pulverulenta* L.: S. Afr. (Orange River mouth to Port Elizabeth, etc.); W. Afr.; Azores.

## THYMELAEACEAE.

*Passerina rigida* Wikst.: S. Afr. (Cape to Natal, mainly a dune-plant, but in some places reaches the upper-beach).

## LYTHRACEAE.

*Pemphis acidula* Forst.: E. Afr.; Seych.; Malaya (in D.E.I. general on sandy and rocky coasts) to Pacific. Dispersed by sea, possibly by floating logs and pumice, and by adhesion of the fruits to plumage of birds.

## SONNERATIACEAE.

*Sonneratia caseolaris* Engl.: P.E. Afr. (Beira, etc.); Seych.; Malaya (D.E.I., in or near mangrove forest borders) to Philipp. and Pac. Seeds dispersed by sea, but probably not over very wide distances. Fruit sometimes eaten by man and monkeys. (= *S. acida* L. f.)

## MYRTACEAE.

*Eugenia cordata* Laws.: S. Afr. (Transkei to P.E. Afr.; in Natal it associates with *Barringtonia*, but also occurs inland in Midlands).

## LECYTHIDACEAE.

*Barringtonia asiatica* L. Kurz: E. Afr. (Pemba); Seych.; Masc. to Malaya (D.E.I., only on sandy strand) and Pacific. Gives its name to the "Barringtonia-Formation" in the East. Fruits sea-dispersed. (= *B. speciosa* Forst.)

*Barringtonia racemosa* Rob.: S. Afr. (Natal, no collections seen by writer from south of vicinity of Durban); Seych.; Masc.; Malaya (D.E.I., on estuaries and borders of mangrove forests) to Pacific. Fruits sea-dispersed.

## RHIZOPHORACEAE.

*Rhizophora mucronata* Lamk.: S. Afr. (Kei R. mouth, north to borders of the Union); E. Afr. (north to Red Sea) to Malaya (D.E.I.) and Pacific.

*Bruguiera gymnorhiza* Lamk.: S. Afr. (Kei R. mouth, north to borders of the Union); E. Afr. to Malaya (D.E.I.) and Pacific. The name *B. conjugata* Merr. is preferred for this by some botanists.

*Ceriops tagal* Robins: P.E. Afr. (Lourenço Marques); Seych. to Malaya (D.E.I.) and Pacific. This name is preferred to *C. candolleana* Arn. by some later authors.

## COMBRETACEAE.

*Lumnitzera racemosa* Willd.: P.E. Afr. (Zambezi R. mouth, etc.); E. Afr.; Seych. to Malaya (D.E.I.) and N. Austr.

*Terminalia catappa* L.: P.E. Afr. (cultivated); Seych.; Mad.; D.E.I. and tropics of Old World. Widely introduced. Fruits sea-dispersed.

## UMBELLIFERAE.

*Cnidium suffruticosum* C. & S.: S. Afr. (Cape to Natal, chiefly on dunes near sea, but also on upper-beach).

*Peucedanum connatum* E. Mey.: S. Afr. (Pondoland, Natal, on seashore and borders of salt marshes; also inland).

*Apium graveolens* L.: S. Afr. (west coast to Natal on sandy beaches, rocks on coast, and in saline marshes; also inland in vleis); N. Afr.; Eur.; W. Asia, etc.; fruits non-buoyant.

*Seseli asperum* Sond.: S. Afr. (beach and dunes near Capetown).

## PLUMBAGINACEAE.

*Statice scabra* Thunb.: S. Afr. (Namib to neighbourhood of Bathurst on seashores and dunes; also inland to 500 feet).

*S. linifolia* L.f.: S. Afr. (a maritime form at Riversdale in halophilous marshes with *Arthrocnemum* spp.; on rocks just above reach of tide on Kentani coast). The species with its varieties is widely distributed inland up to 5,000 feet.

## GENTIANACEAE.

*Chironia baccifera* L.: the variety *Burchellii* occurs on the upper-beach on sand and rocks on the Riversdale coast; the variety *dilatata* at East London, etc.

*C. maritima* Eckl.: S. Afr. (Cape to Port Elizabeth on sandy seashores, dunes, and in saline meadows; and inland).

## APOCYNACEAE.

*Cerbera manghas* L.: E. Afr. (Pemba, Zanzibar); Seych.; Mad.; Malaya (D.E.I.) to Pacific. Sea-dispersed.

*Voacanga Dregei* E. Mey. associates with *Barringtonia* in Natal, but is not a true strand-species.

## ASCLEPIADACEAE.

*Schizoglossum euphorbioides* E. Mey.: S. Afr. (Pondoland to Natal, sometimes on shore; but it is rather a dune plant).

Several species of *Cynanchum* (*C. obtusifolium* E. Mey., *C. natalitium* Schltr., *C. africanum* R. Br. which has a maritime variety *crassifolium*, and *C. Zeyheri* Schltr.) may be found growing on the shore. They occur also inland and are not true strand species. As a matter of interest I may mention that I have caught seeds of the first and third of these at Still Bay in a boat out at sea or while bathing. They are wafted through the air with their parachute of hairs. The separated seeds are non-buoyant.

## BORRAGINACEAE.

*Tournefortia argentea* L.: P.E. Afr.; E. Afr.; Seych. to Malaya (D.E.I. on rocky coasts and sandy strand), and Pacific. Fruits sea-dispersed.

*Cordia subcordata* Lamk.: E. Afr.; Malaya (D.E.I., rocks at the sea and sandy seashore) to Pacific. Sea-dispersed.

*Heliotropium curassavicum* L.: S. Afr. (S.W. Afr.; Lambert's Bay near beach in sand; Uitenhage; salt-pans in Transvaal; widely distributed inland); E. & W. Afr.; Austr.; Pacific, etc. Seeds not buoyant but possibly transported on logs and pumice.

## CONVOLVULACEAE.

*Ipomoea Pes-caprae* Roth.: S. Afr. (Mossel Bay to Delagoa Bay, a littoral plant with sea-dispersed seeds). On most tropic and sub-tropic coasts. Common in D.E.I.

*I. stolonifera* Gmel.: S. Afr. (cited by Thunberg but without locality and I have seen no South African specimens); Angola; Mediterr.; India; Malaya (D.E.I.), etc. A strand-plant with sea-dispersed seeds. (= *I. carnosa* R. Br.)

*Calystegia Soldanella* R. Br.: S. Afr. (Riversdale); Tristan da Cunha; N. Afr.; Kermadec Is.; Austr. (N.S. Wales, Queensland); N.Z.; S. Amer.; Eur. Not in Dutch East Indies. A strand-plant with sea-dispersed seeds.

*Stictocardia campanulata* (L.) Merr.: E. Afr.; Seych.; Masc.; Ceylon; Indo-mal. (D.E.I. on coast and inland); W. Afr.; Pacific, and almost pantropical. A large species of the seashore and coastbelt and occurring inland. Seeds variable in buoyancy with some capacity for sea-dispersal. (= *Argyrcia tiliacfolia* Wight).

*Calonyction album* House: E. Afr.; Seych.; Mad.; Malaya (D.E.I., in *Pes* and *Barringtonia*) to Pacific. Dispersed partly by sea and partly by man: a strand-plant on shrubs and trees. [= *C. grandiflorum* (Lambk.) Choisy.]

The following species are not strand-plants, but two of them, *Ipomoea cairica* and *Calonyction aculeatum*, produce seeds which are present in the South African drift. It is suspected that some of the others may also appear there, but cultivation tests in a conservatory are still required to decide this.

*Ipomoea cairica* (L.) Sweet: S. Afr. (Port Elizabeth to Lourenço Marques in coastscrub and river-bush); Trop. Afr.; N. Afr.; Trop. Asia; Seych., etc. (= *I. palmata* Forsk.)

*I. congesta* R. Br.: S. Afr. (Natal, in coastbelt).

*Calonyction aculeatum* (L.) House: S. Afr. (cultivated near the coast); pantropical. Seeds buoyant. [= *C. Bona-nor* (L.) Boj.]

*Operculina turpethum* Manso: S. Afr. (Rhodesia); D.E.I. Widely distributed in tropics but usually inland. Seeds irregularly buoyant, dispersed partly by water, and also by man. (= *Ipomoea turpethum* R. Br.)

*Merremia peltata* (L.) Merr.: Seych.; Masc.: Malay Peninsula to Pac. and Philipp. Found in coastbush and on riverbanks. Seeds irregularly buoyant and appear in beach-drift of various countries. (= *Ipomoea peltata* Choisy.)

*Ipomoea digitata* L. is a coastscrub species found in Natal, Zululand, and at Lourenço Marques (also inland in D.E.I.), but the seeds obtained from Natal and North America were non-buoyant when tested at Riversdale in my home.

#### VERBENACEAE.

*Lippia nodiflora* Rich.: S. Afr. (Natal, a creeping plant of the *Pes*); P.E. Afr. (Lourenço Marques in the *Pes*); Seych.; Indo-mal. (D.E.I., on strand and inland to 480 feet); pantropical.

*Premna corymbosa* (Burm. f.) Rottl. & Willd: E. Afr.; Seych. to China, Philipp., and Pac.; a littoral plant (= *P. serratifolia* L.)

*Avicennia marina* (Forst.) Vierh.: the variety found in E. Afr.; Arabia; Seych.; Natal, and Masc. is *typica* Bakh. The form occurring in Java is *alba* Bakh.

*A. officinalis* L.: India (Madras, Bengal, Sundribuns); Andamans; Java; Celebes; Philipp., etc.

*Lantana Camara* L.: S. Afr. (recorded only from inland); in D.E.I. (on strand, in the mangrove, and inland).

#### SOLANACEAE.

Some species of *Solanum* may descend to the upper-beach from the coastscrub, viz.:—*S. quadrangulare* Thunb.; *S. nigrum* L. which has a coast form with more succulent, scarcely-lobed leaves; and *S. Aggerum* Dun., which occurs on the Knysna coast (the only locality recorded in the *Flora Capensis*), on the upper-beach and dunes. *Lycium tetrandrum* Thunb. is partial to the upper-beaches and coast dunes from Piquetberg to Knysna, but also occurs far in the interior up to 3,500 feet.

#### SCROPHULARIACEAE.

*Hebenstreitia cordata* L.: S. Afr. (Namaqualand to Riversdale, rather characteristic of sandy places and rocks of upper-beach, but found inland).

*Manulea tomentosa* L.: occurs on the seashore, fore-dunes, and inland from the Cape to Riversdale; and *Zaluzianskya maritima* Walp. on seashores, dunes, and inland up to a very high altitude.

#### ACANTHACEAE.

*Acanthus ilicifolius* L.: S. Afr. (the occurrence of this mangrove-component of the East at Uitenhage is very remarkable; introduced).

*Chaetacanthus Persoonii* Nees is found in the outer halosere at Durban, and ascends elsewhere to 2,000 feet: it is hardly a true strand-plant. *Asystasia coromandeliana* Nees is a weed in the Pes of Pondoland and P.E. Afr., and also grows inland.

#### MYOPORACEAE.

*Myoporum acuminatum* R. Br.: S. Afr. (an introduced tree, often planted on the coast quite close to the sea and inland. The fruit is eaten by man, birds and stock, and seedlings appear on the beaches, from seeds thus conveyed).

#### PLANTAGINACEAE.

*Plantago carnosus* Lamk.: S. Afr. (frequent on the beach from Piquetberg to East London; also inland).

#### RUBIACEAE.

*Hydrophyllus carnosus* Sond.: S. Afr. (Riversdale to Natal; a coast halophyte; fruits non-buoyant).

*Guettarda speciosa* L.: P.E. Afr.; E. Afr. Seych to Malaya (D.E.I., on the sandy and rocky strand) and Pacific. Fruits sea-dispersed.

*Randia dumetorum* Lamk.: S. Afr. (Natal, near coastscrub margin); E. Afr.; D.E.I. (on strand and in woods up to 2,900 feet); China.

*Morinda citrifolia* L.: E. and W. Afr.; Seych.; Mal. (D.E.I., general on strand and cultivated in interior) to Pacific. Dispersed partly by sea, and probably by bats, birds, and other animals.

*Anthospermum littorale* occurs on upper-beach and dunes near East London and in the Transkei.

*Pachystigma latifolia* is not a true strand species.

#### CAMPANULACEAE.

*Lobelia halophila* Schltr.: S. Afr. (Cape Pen. on the rocks on the seashore). May be merely a maritime form of *L. pubescens* Ait., which occurs inland in rocky places in coastbelt (including varieties) from Cape Pen. to George.

*L. anceps* Thunb., a strand and inland species in Australia, found also in New Zealand and Chile, is common in wet places in S. Africa in non-maritime localities.

#### GOODENIACEAE.

*Scaevola Plumieri* Vahl: S. Afr. (Bredasdorp to Delagoa Bay on upper-beach but more typically on dunes); P.E. Afr. (Beira); E. Afr. (Zanzibar, Mombasa, Pangani, Luabo R.); Somaliland; Maur.; Mad.; not in Seych.; apparently not in Java; India (Madras, Bombay); W.I.; N. Amer. (Florida, Mexico); Brit.

Hond.; Brazil; W. Afr. (Senegal to Angola near Benguela). Dispersed widely by currents and locally by birds and sea. (= *S. Thunbergii* E. & Z. and *S. Lobelia* L.)

*S. frutescens* (Mill.) Krause: E. Afr. (Zanzibar, Mombasa, Pemba); Chagos Arch.; Seych.; Aldabra; Johanna Is.; Maur.; Mad.; India; Malaya (in D.E.I. common on sandy and rocky strand) to Austr. and Pacific. Dispersed by currents and birds. (= *S. Koenigii* Vahl.)

The two species overlap in E. Afr. Mad.; Maur.; India and Ceylon.

#### COMPOSITAE.

*Cryptostemma nivicum* Nichols: S. Afr. (Clanwilliam to Natal on sandy strand and foremost dunes). Not seen by the writer in P.E. Afr.

*Gazania uniflora* Sims: S. Afr. (Riversdale to Natal including varieties, on rocky beaches, cliffs, and shingle, and also on sand).

Another species of *Gazania*, undetermined, is found on shingle beaches in the Cape Peninsula.

*Osteospermum moniliferum* L.: S. Afr. (all round coast on upper-beach and dunes, and also inland); not strictly a strand species.

*Dimorphotheca fruticosa* Less.: S. Afr. (Cape to Natal on sandy upper-beach, common; a true strand species).

*Othonna lapidosa* Hutch & Dyer (ined.): S. Afr. (Riversdale, Muir 3128!); a true halophyte.

*Senecio maritimus* L. II S. Afr. (Table Bay, Struis Bay, Riversdale coast, etc., often growing among drift on the seashore, sandy upper-beach, and front dunes).

*S. elegans* L.: S. Afr. (Cape to Bathurst on upper-beach, variety *diffusus*, but the species is more typical of the dunes further back; also inland).

*Brachylaena discolor* DC.: S. Afr. (Uitenhage to Delagoa Bay); P.E.A. (north to Inhambane). Inland to 2,000 feet. May occur on upper-beach, but more usually occurs further back on the front dunes as a partial halophyte.

*Lamnaca bellidifolia* Cass.: S. Afr. (Uitenhage to Delagoa Bay on sand dunes and in the *Pes*); P.E. Afr. (Beira, Zambezi River mouth); Kenya, creeping along the coral rocks at Likoni; Zanzibar; Mad.; Maur.; Aldabra Group; Cosmo Lido Is., etc. Common on shores of Indian Ocean. Very rare in Java, and unknown from the surrounding islands. (= *Microrhynchus sarmentosus* DC.).

*Helichrysum teretifolium* Less.: S. Afr. (Cape to Natal, on upper-beach, but common inland, and not a true strand-plant).

*H. cricacifolium* Less. var. *albidulum* DC. appears on the upper-beach of Riversdale, Uitenhage, Natal, etc., and also inland; *H. littorale* Bolus on the upper-beach and dunes at East London; and *Leontonyx spathulatus* Less. var. *candidissimus* Harv. on upper-beach and also inland.

*Wedelia biflora* Wight: E. Afr. (common on seashore; at Pemba growing just above high-water mark; Zanzibar, etc.); India; Andamans; Malaya (D.E.I., very general, and nearly always on the strand); Austr.; S. China. Sea-dispersed.



*Aster ficoideus* Harv.: S. Afr. (Cape to Bathurst, a succulent of damp brackish localities often near mouths of rivers).

*Matricaria sabulosa* Dod: S. Afr. (Cape Pen. on beach and dunes).

*Cotula coronopifolia* L. is found in S. Afr. in both saline and freshwater marshes, and is common inland; also in Eur.; Asia; Austr. and S. Amer. *Othonna carnosa* Less. var. *discoidea* is a halophyte in Natal; the typical white-rayed form is common behind the beach in Riversdale.

#### FILICES.

*Chrysodium aureum* Mett.: S. Afr. (Natal, Zululand); P.E. Afr.; D.E.I. (coastal marshes and inland); pantropical. The "Mangrove Fern".

#### BRYOPHYTA.

*Frullania diptera* L. & L.: S. Afr. (in *Barringtonia*, but also inland on stones and bark from Cape to Rhodesia).

*Macromitrium lycopodioides* (Burch.) Schw.: S. Afr. (in same situations from Cape to S. Rhodesia).

*Hypnum maritimum*, *Braunea maritima*, and *Grimmia maritima* are doubtful species. *Riella capensis* Cavers is not a halophytic plant, and does not grow in tidal pools.

#### CHAROPHYTA.

*Chara stachymorpha* Giant.: S. Afr. (characteristic of brackish water).

*C. vulgaris* L.: S. Afr. (often in slightly brackish water, but not so characteristically as preceding species).

*C. fragilis* Desv.: S. Afr. (often in slightly brackish water).

*Lamprothamnium papulosum* J. Groves: S. Afr. (occurs both in brackish and in fresh water).

The above Charophytes are quoted on the authority of Miss E. L. Stephens.

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## APPENDIX.

## I. MEAN SURFACE TEMPERATURE OF THE SEA.

	Jan.	Feb.	Mar.	Apr.	May.	Jun.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Aver.
Walvis Bay.....	—	—	—	—	—	53.1	52.8	52.9	56.3	57.1	55.4	59.1	—
Dassen I.....	58.5	57.3	56.6	56.0	56.3	56.1	55.8	55.3	53.9	55.7	56.9	58.4	56.4
Blaauwberg Str....	60.0	59.0	57.8	56.1	55.8	54.9	54.5	54.6	54.2	56.8	56.9	58.7	56.6
Danger Point.....	65.2	62.5	60.1	59.2	59.2	58.6	58.3	58.3	58.2	59.2	60.0	61.8	60.0
Knysna Heads.....	67.6	69.4	66.0	64.3	62.2	66.0	56.5	57.7	57.6	58.9	61.1	65.6	62.7
C. St. Francis.....	68.5	68.4	65.2	64.1	63.1	62.1	60.0	59.0	58.4	59.9	62.4	65.6	63.0
East London.....	69.0	63.9	60.9	61.2	62.1	61.5	60.9	60.0	62.3	62.4	63.6	65.9	62.8
Port St. Johns....	68.5	68.8	68.6	69.1	66.2	61.4	62.6	63.8	64.2	65.1	65.1	65.6	56.7
Durban.....	74.5	74.9	74.6	72.7	68.7	61.2	64.3	64.7	66.3	69.1	71.8	73.6	69.7

The above statistics, with the exception of those for Durban, which were supplied to me by letter by the Chief Meteorologist of the Union of South Africa, have been compiled from the Reports and other publications of the Meteorological Office of the Union of South Africa.

They show the contrasts in the temperature of the sea under the influence of different ocean currents.

Temperature of the sea is an important factor in causing germination of the floating seed in the water, which in many cases leads to its sinking.

It has been found that tropical seeds can be kept in sea-water at a temperature sufficient to freeze fresh water for a period of three weeks without preventing subsequent germination. (Guppy, *N.P.* II. 531).

At Knysna and elsewhere on our south and east coasts there is strong evidence that the arrival of cold water causes the temporary disappearance of fish, which may also become comatose. Melting snow from the Basutoland mountains causes the water of the Orange River at Aliwal North to become so cold that fresh water fish are unable to escape and are caught without difficulty. (*Die Burger*, 31.8.1931). Guppy (*N.P.* II, 600) mentions a similar phenomenon on the coast of Peru in the case of fish, and A. Smith (*Temperate Chile*) in the case of octopi. These facts have an interesting biological relation.

## II. TIDAL RANGE IN SOUTH AFRICA.

The figures given herewith, extracted from the "Admiralty Tide Tables", enable some idea to be obtained of the height of the tides in South African waters, and were supplied to me by H.M. Astronomer, Royal Observatory, Cape Town.

1. *Simons Bay.*

	Highest High Water.	Lowest High Water.	Highest Low Water.	Lowest Low Water.	Total Range.
	Feet. 5·6	Feet. 3·7	Feet. 2·3	Feet. 0·4	Feet. 5·2
January.....	6·0	3·6	2·8	0·5	5·5
April.....	5·5	3·6	2·0	0·2	5·3
July.....	5·7	3·4	2·5	0·1	5·6
October.....					

2. *Durban.*

	Highest High Water.	Lowest High Water.	Highest Low Water.	Lowest Low Water.	Total Range.
	Feet. 6·1	Feet. 3·5	Feet. 2·4	Feet. 0	Feet. 6·1
January.....	6·4	3·4	2·6	— 0·4	6·8
April.....	5·8	3·4	1·6	0·0	5·8
July.....	6·4	3·3	2·7	— 0·5	6·9
October.....					

The amount of inundation by the sea depends on the height of the tides as well as on the height of the terrain.

Meindertsma states that the average difference between ebb and flow at the Kindersee, on the south coast of Java, is probably about 1·5 metres; in Palembang, on the east coast of Sumatra, 3·4 metres; and in Indragiri, north of the latter site, 5 metres. (*De Trop. Natuur*, XII, 1923).

The amount of inundation has an important bearing on the life of a number of strand-plants.

III. NOTE ON *MUCUNA* *ALTISSIMA* DC. AND *M. FLAGELLIPES* VOGEL.

I have stated in Chapter II, § 1, that the seeds of *M. altissima* DC. of the West Indies, and of *M. flagellipes* Vogel of West Africa are to my eyes indistinguishable. The former has in the past caused much difficulty to writers on this subject, and is the seed washed up in Europe which is named by the older authors, and in museums, "*Mucuna* sp. near *M. urens* DC." If the species are identical it

would solve an age-old problem. At my request Sir A. W. Hill asked Mr. John Hutchinson to examine the herbarium material of these plants, with the following result:—

- M. altissima* DC. Leaflets shortly and usually gradually acuminate; upper bracts of inflorescence soon falling off. Calyx silky pubescent but not setose as well; fruits more or less transversely wrinkled but hardly lamellate; inflorescence in fruit elongate-zigzag.
- M. flagellipes* Vogel. Leaflets abruptly long-tailed-acuminate; upper bracts persistent until fruiting time; calyx silky and setose-pubescent; fruits markedly transversely lamellate; inflorescence in fruit very closely zigzag, the scars of the pedicels close together.

Mr. Hutchinson thinks they are separable, although the differences "taken separately would not amount to much". The herbarium material of *M. altissima* was not quite satisfactory.

I think that the possibility of *M. altissima* DC. being derived from *M. flagellipes* Vogel from sea-dispersed seeds has to be borne in mind, and that differences may possibly be due to habitat.

The problem is of such deep significance from the point of view of oceanic dispersal and origins, that it would be worth while to obtain a wide range of collections of the plants from the West Indies and West Africa respectively for further investigation. I have one of Guppy's seeds of "*Mucuna* sp. near *M. urens*", given to me by the British Museum, and a large number of seeds of *M. flagellipes*, which I collected in West Africa.

## GENERAL INDEX.

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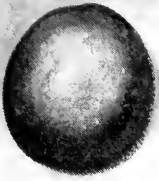
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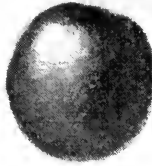
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*Zygophyllum Morysonia*, 42.



1



2



3



4



5



6



7



PLATE I.

1-3 *En tuda gigas*; 4-7 *Intsia bijuga*. Riversdale drift. All collected by J. Muir.



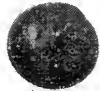
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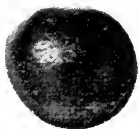


15



PLATE II.

8-11 *Mucuna myriaptera*; 12-15 *M. gigantea*. Riversdale drift. All collected by J. Muir.



238



806



1064



1550



1484



PLATE III.

238 *Mucuna* or *Dioclea*; 806 *Mucuna myriaptera*, a form; 1064 *M.* sp.; all from Riversdale drift; 1550 *M. urens* from Lagos, W. Africa, and 1484 *M. flagellipes* from Duala, French Mandated Territory of Cameroons; all collected by J. Muir.



16



17



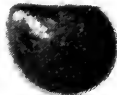
18



247



19



20



21



22



PLATE IV.

16-18 *Dioclea reflexa*, spotted; 247, same, a form; 19-20 same, unspotted; 21-22, same, thick type. Riversdale drift collected by J. Muir.

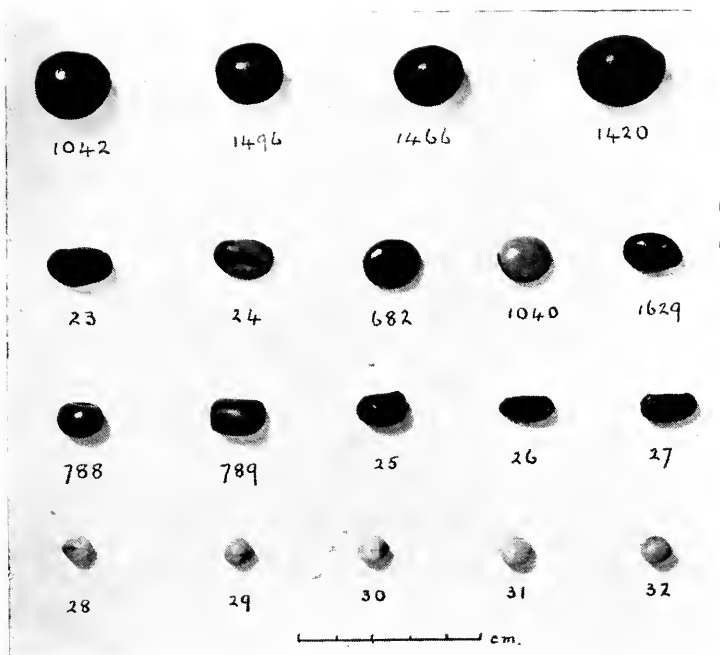


PLATE V.

1042 *Strongylodon ruber*, Riversdale drift, collected by J. Muir; 1496 same, Ceylon, obtained by exchange from Royal Botanic Gardens, Kew; 1466 same, Fiji, collected by Dr. H. B. Guppy; 1420 same, Hawaii, given by G. P. Wilder, Honolulu. All in Muir collection. 23-24 *Canavalia obtusifolia*; 682, 1040 *C. bonariensis*; 1629 *C. microcarpa*; all from Riversdale drift collected by J. Muir. 788-789, 25 *Erythrina variegata* var. *orientalis*; 26-27 *E. fusca*; all from Riversdale drift collected by J. Muir. 28-32 *Sophora tomentosa*, Riversdale drift collected by J. Muir.

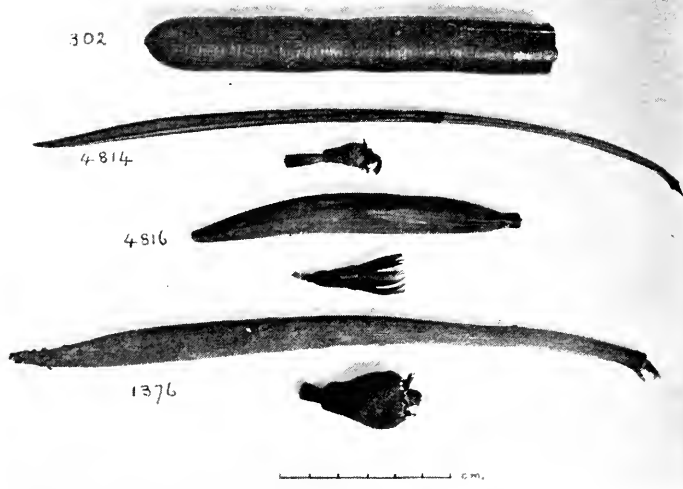


PLATE VI.

302 *Cassia fistula*, fragment of pod, Riversdale drift; 4814 *Ceriops tagal*; 4816 *Bruguiera gymnorhiza*, and 1376 *Rhizophora mucronata*; all from drift of Lourenço Marques. Collected by J. Muir.



PLATE VII.

1213 *Heritiera littoralis*, Beira drift, collected by Miss H. J. Muir; 4775 *Terminalia catappa*, drift of Lourenço Marques, collected by J. Muir; 521 *Aleurites triloba*, Riversdale drift, collected by J. Muir; 1104 same, from Natal; 37 *Mangifera indica*; 1046, 1038 *Bairingtonia racemosa*; all from Riversdale drift, collected by J. Muir.



1666



1546



1652



4861



1152



#### PLATE VIII.

1666 *Sonneratia caseolaris*, Beira drift, collected by Miss H. J. Muir; 1546 *Elaeis guineensis*, W. African drift, collected by J. Muir; 1652 *Hyphacne crinita*, drift of Inhambane, Portuguese East Africa, and 4861 *Telfairia pedata*, drift of Inhambane, both collected by Dr. C. J. Stauffacher, but not sea-dispersed; 1152 *Calophyllum inophyllum* from Java, and in drift of much of Indian Ocean littoral and effectively sea-dispersed.

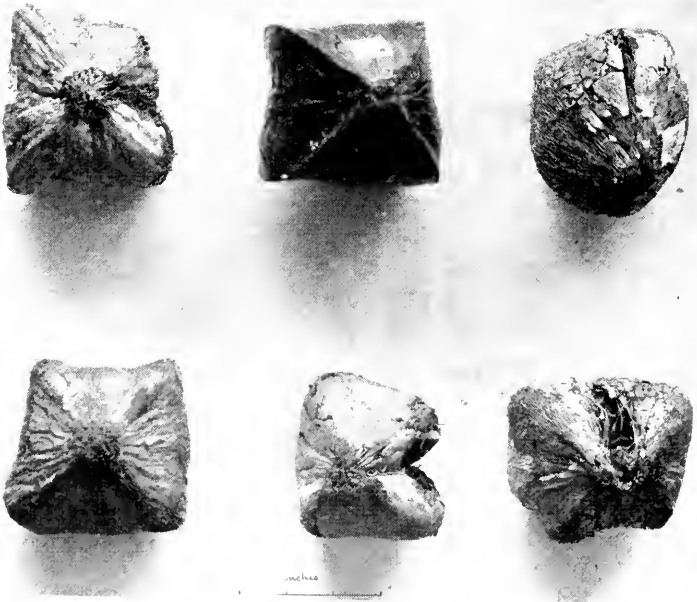


PLATE IX.

*Barringtonia asiatica*, fruits from Riversdale drift, some eroded and swimming layer exposed. Collected by J. Muir.

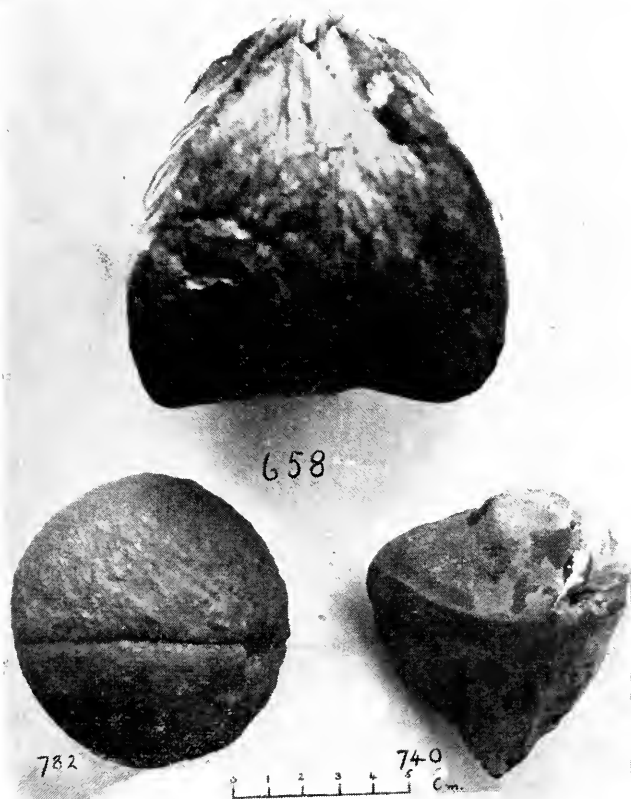


PLATE X.

658 *Barringtonia asiatica*, fruit from Riversdale drift; 782 *Xylocarpus granatum* fruit from drift of Lourenço Marques; 740 *X. moluccensis*, seed from Riversdale drift. All collected by J. Muir.



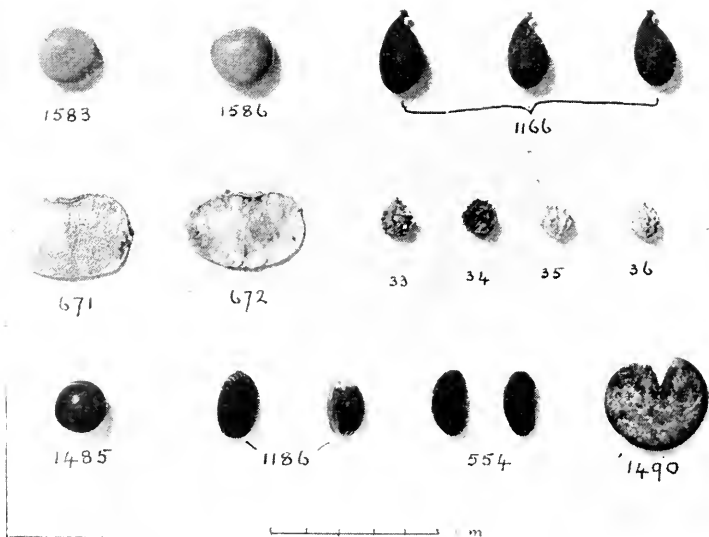


PLATE XI.

1583, 1586 *Caesalpinia crista*, Riversdale drift; 1166 *Dialium Schlechteri*, fruits from Inkomati River estuary drift; 671-672 *Derris trifoliata*, pods from Lourenço Marques drift; 33-36 *Scaccola Plumieri*, and 1485 *Hernandia peltata*, Riversdale drift; 1186 *Jatropha Curcas*, Inkomati River estuary drift. Portuguese East Africa; 554 *Pachystigma* sp., Riversdale drift; 1490 *Drepanocarpus lanatus*, Gold Coast, W. Africa, in drift. All collected by J. Muir.

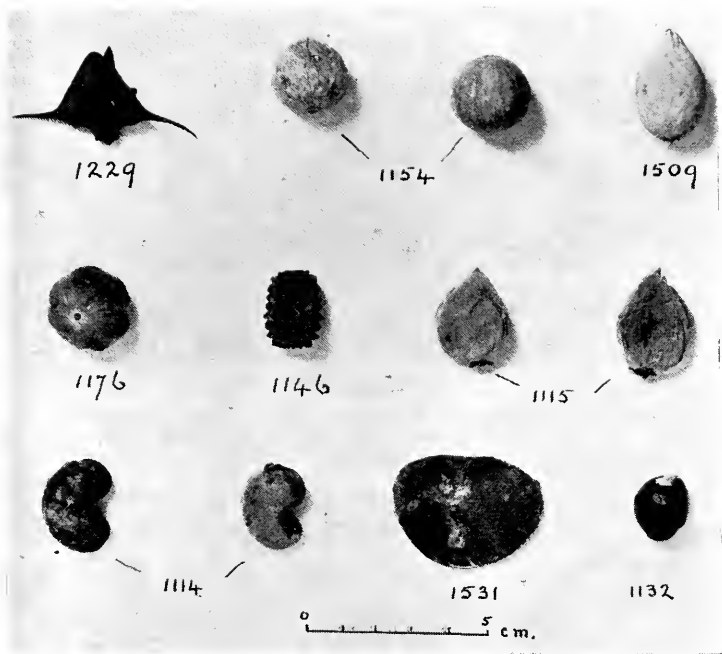


PLATE XII.

1229 *Trapa bispinosa*, and 1154 *Cryptocarya latifolia*, Riversdale drift, collected by J. Muir; 1509 *Ximenia americana*, Gold Coast, given by Achimota College, Accra; 1176 *Guettarda speciosa*, fruit from Ceylon, given by Dept. of Agric., Ceylon; common in drift of East Africa and other shores of Indian Ocean; 1146 *Casuarina equisetifolia*, drift of Lourenço Marques; 1115 *Aricennia marina* var. *typica*, seedlings from drift near Durban; 1114 *Anacardium occidentale*, drift of Lourenço Marques; 1531 *Ecastaphyllum Brownei*, pod from Pointe-Noire, French Equatorial Africa; 1132 *Calodendron capense*, seed from drift at East London. All collected by J. Muir.

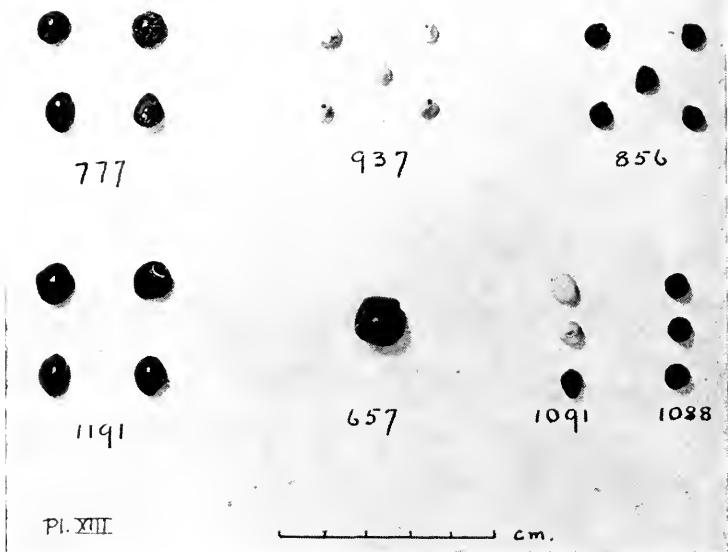


PLATE XIII.

777 *Ipomoea Pes-caprae*; 937 *I. carica*; 856 *Calystegia Soldanella*; 1191 *Calonyction aculeatum*; 657 *Ipomoea* sp.; 1091 *I.* sp.; 1088 *I.* sp. All from Riversdale drift.

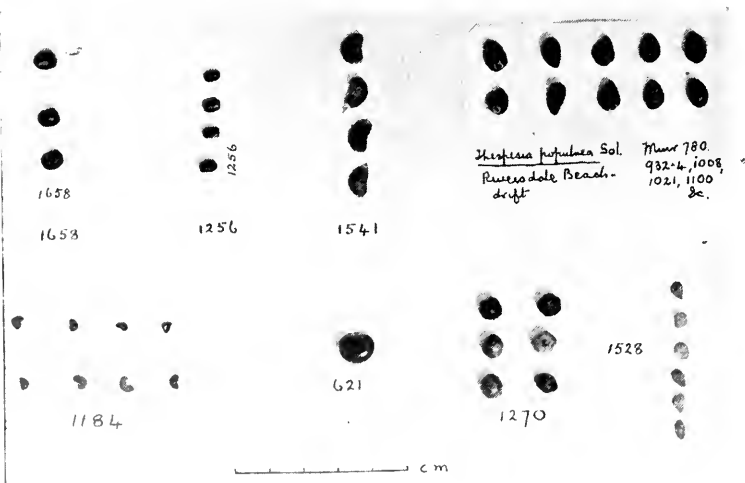


PLATE XIV.

1658 *Ligna marina*, E. Africa; 1256 *V. luteola*, Riversdale drift; 1541 *Dendrolobium umbellatum*, joints of pod, E. Africa; 780, etc. *Thespesia populnea*; 1184 *Hibiscus filaceus*; 621 *Adansonia digitata*; and 1270 *Sideroxylon inerme*, all from Riversdale drift; 1528 *Tacca leontopetaloides*, from Java, seeds collected by Dr. H. B. Guppy, received by exchange from Kew.

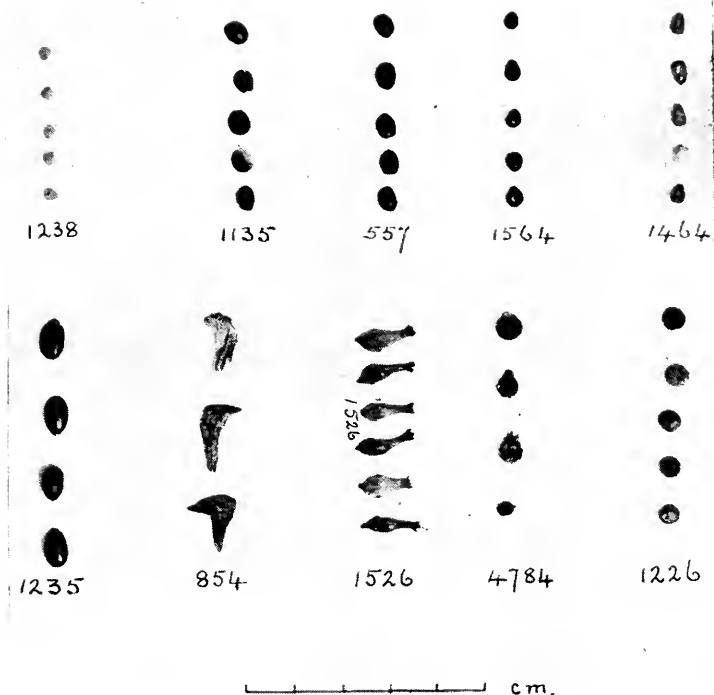
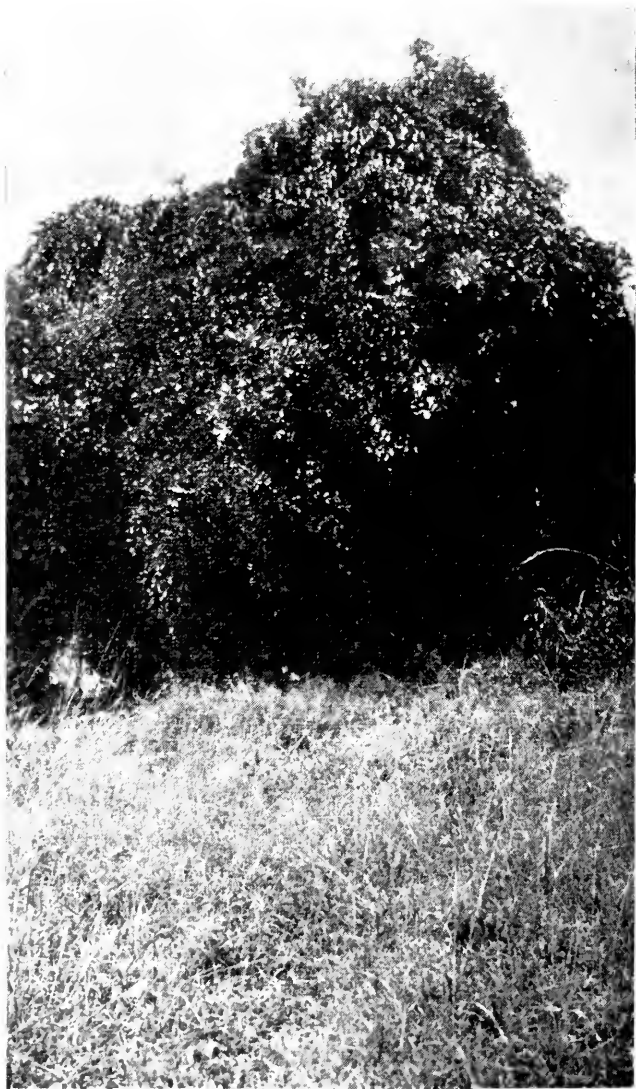


PLATE XV.

1238 *Suriana maritima*, and 1135 *Colubrina asiatica*, both of seeds from Ceylon, but also present in E. and S. African drift; 557 *Noltia africana*, and 1564 *Helinus ovata*, seeds from Riversdale drift; 1464 *Wedelia biflora* from Java, but present in E. Africa; 1235 *Ricinus communis*, seeds from Riversdale drift; 854 *Sonneratia caseolaris*, seeds from drift of Inhambane; 1526 *Lumnitzera racemosa*, fruits from Java, but others were found by Miss H. J. Muir in drift at Beira; 4784 *Cassytha filiformis*, fruits from drift of Lourenço Marques; 1226 *Tournefortia argentea*, fruits from Ceylon, but present in drift of E. Africa, and other shores of Indian Ocean.



PHOTOGRAPH 1.

*Eulalia quipus* covering *Barringtonia racemosa* and *Hibiscus tiliaceus*. *Mucuna gigantea* also appears in the photograph, but cannot be distinguished from the other growth. Inkomati River, Portuguese East Africa.



PHOTOGRAPH 2.

. *Entada gigas* covering *Barringtonia racemosa* and *Hibiscus tiliaceus* Inkomati River, Portuguese East Africa.



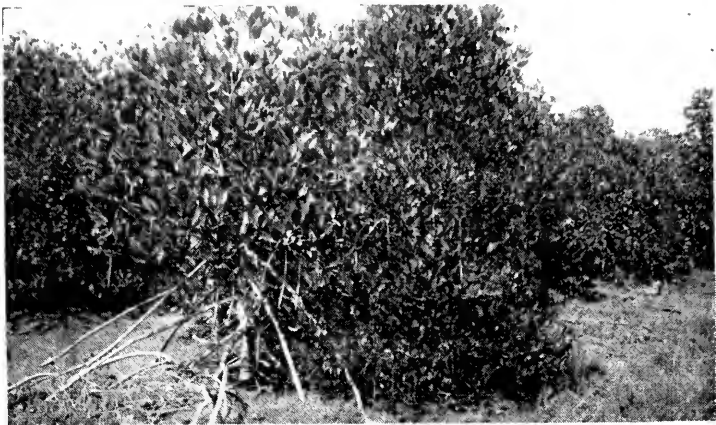
PHOTOGRAPH 3.

*Entada gigas* on *Barringtonia racemosa* and *Hibiscus tiliaceus*; main upright stem and one horizontal stem 18 inches in diameter running down into water of the Inkomati River, Portuguese East Africa.



PHOTOGRAPH 1.

*Rhizophora mucronata* on creeks at Catembe, Portuguese East Africa; with  
*Sesuvium portulacastrum* and *Arthrocnemum indicum* in foreground.



PHOTOGRAPH 5

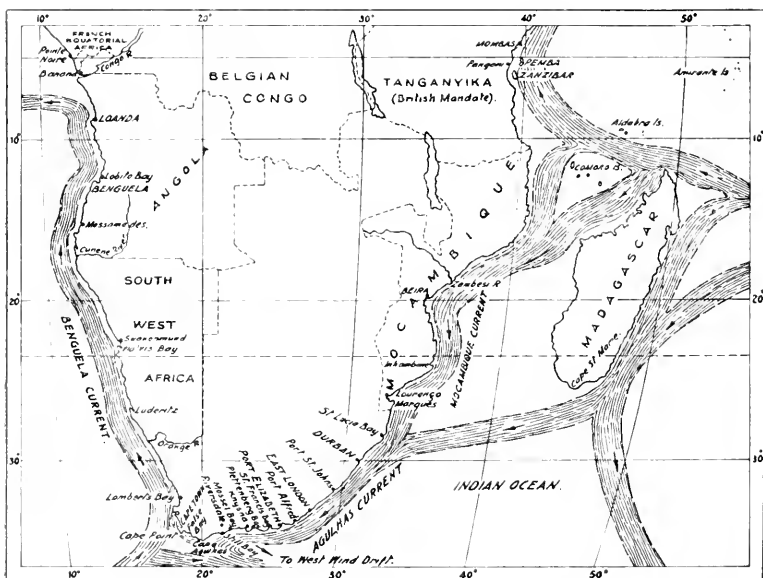
*Rhizophora mucronata* in foreground, with *Avicennia marina* var. *typica* to right and left; and *Bruguiera gymnorrhiza* in right background. Catembe, Portuguese East Africa.



PHOTOGRAPH 6.

*Caesalpinia crista* on a ruined building about 15 feet high Catembe, Portuguese East Africa, near sea.





Drawn on the lines of Schimper, Guppy, etc., showing localities mentioned in the text, and also, diagrammatically, the course of the surface flow of the main currents concerned in seed-dispersal. Use has been made of the Pilot Charts sent to the writer from Washington, U.S.A. (Hydrographic Department), which give the average monthly set of the stream and drift currents, and also of Dr. G. Schott's bottle-drift records. Local currents on the South African coasts, some of which flow in a direction opposite to that of the Agulhas Current are not indicated; but they may be of some local importance in seed-dispersal.



UNION OF SOUTH AFRICA

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DEPARTMENT OF AGRICULTURE AND FORESTRY

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DIVISION OF PLANT INDUSTRY

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BOTANICAL SURVEY MEMOIR No. 17

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**THE VEGETATION OF THE DIVISIONS**  
— OF —  
**ALBANY AND BATHURST**

(With 4 maps, 4 diagrams and 42 photographs, being the thesis submitted in partial fulfilment of the regulations governing the degree of D.Sc. in the University of South Africa, 1936)

— by —

**R. A. DYER, D.Sc. (South Africa)**  
Botanist, Division of Plant Industry, Pretoria, South Africa

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UNION OF SOUTH AFRICA

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DEPARTMENT OF AGRICULTURE AND FORESTRY,  
DIVISION OF PLANT INDUSTRY,  
P. O. Box 994,  
PRETORIA.

11th. June, 1937.

THE SECRETARY FOR AGRICULTURE AND FORESTRY,  
PRETORIA.

Sir,

I have the honour to forward herewith the typescript of a paper prepared by Dr. R.A. Dyer of this Division, entitled "The Vegetation of the Divisions of Albany and Bathurst," and beg to recommend that it be published as Botanical Survey Memoir No. 17.

The paper forms a very valuable addition to our knowledge of the vegetation and flora of the south-eastern part of the Province of the Cape of Good Hope, and since it deals with the meeting ground of three distinct floras, viz :—the Cape, the Karroo, and the sub-tropical coast belt, it is of considerable botanical interest.

The paper has the added advantage that Dr. Dyer had the opportunity of checking the nomenclature of most of his material in the Herbarium of the Royal Botanic Gardens at Kew, and while he was stationed at Grahamstown had at his complete command the unique collections in the Albany Museum at that centre.

The work done will further serve as a most valuable prelude to the intensive study of the veld which is so desirable in our veld-management and watershed-protection programme of research.

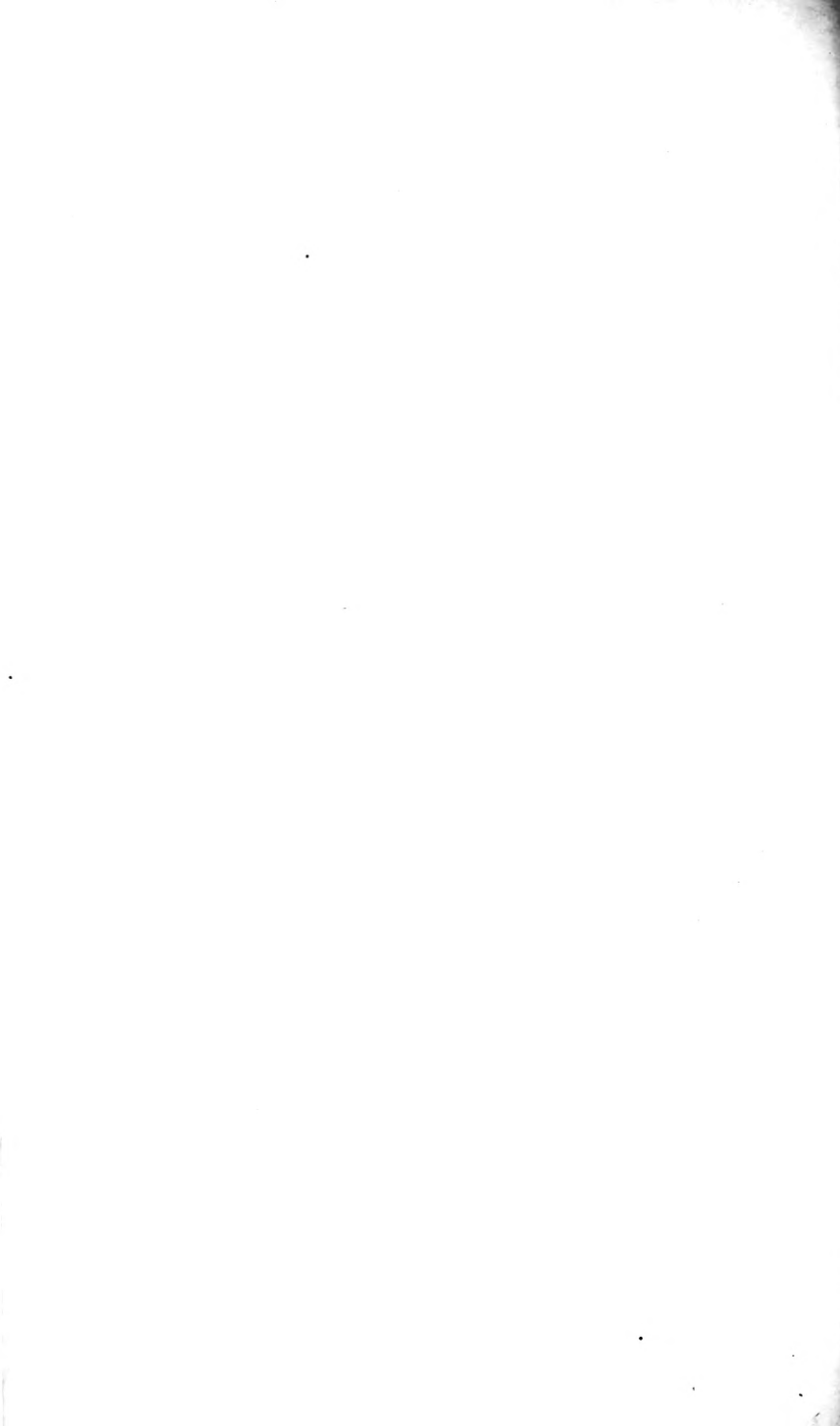
This memoir will also form a companion to the two already published, viz :—No. 1 "Phanerogamic Flora of the Divisions of Uitenhage and Port Elizabeth" by S. Schonland, and No. 13 "The Vegetation of the Riversdale Area" by J. Muir.

I have the honour to be,

Sir,

Your obedient Servant,

(Sgd.) I. B. POLE EVANS.  
*Director, Botanical Survey.*



## INTRODUCTION.

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THE Vegetation of the Divisions of Albany and Bathurst is particularly interesting owing to the great diversity of its components. The area in question which is situated in the south-eastern part of the Cape Province, is a meeting ground of three very distinct Floras, viz., the South-Western Cape Flora, a Subtropical Flora from Natal, and the Karroo Flora. The South-Western Flora, characterised by such genera as *Erica*, *Aspalathus*, *Phylica*, *Metalasia* and *Berzelia*, occurs here in relatively small patches. These are outliers of the main stream from the Cape which has been checked somewhat abruptly in the Uitenhage Division near the Van Staadens Pass. Locally it gives character to Fynbos. The Subtropical Flora in itself is very diversified, and far more so than the South-Western Flora. In addition to supplying many elements in Fynbos, it also provides Forest, Bush, Scrub and Grassveld. These formations occupy the greater part of the area under consideration. The Karroo Flora, characterised by dwarf shrubs and succulents, is dominant over small areas in the Fish River valley and mingles with Scrub and larger succulents to form Karroid Scrub in the hot, dry valleys of the Fish and Bushman's Rivers and in similar parts of other river valleys.

The present account is an attempt to forge a further useful link in the series of Botanical Survey Memoirs of South Africa. Its preliminary nature, as a basis for a more exact and detailed study of the vegetation, is fully realised by the writer. The Division of Alexandria separates this area from the Divisions of Port Elizabeth and Uitenhage, the area dealt with by Dr. S. Schonland in Botanical Survey Memoir No. 1. The foundation of my work was laid during my period of service in Grahamstown, 1925-1930, as Government Botanist. On my temporary transfer to the Herbarium of the Royal Botanic Gardens, Kew, I commenced work on a Flora of the area, and at the same time checked the identifications of a large majority of the plants mentioned in the following account of the vegetation. Nearly all the Dicotyledons in the Albany Museum Herbarium were compared with type specimens or authenticated material at Kew, but the nomenclature of the Monocotyledons was not so checked. Thus, if at any time the identity of the plants mentioned is in question, the material in the Albany Museum Herbarium may be referred to for confirmation. I should like to emphasise this point.

The only published work dealing exclusively with the Flora consists of an enumeration of the species of certain families by Dr. S. Schonland, in the Records of the Albany Museum, and a "Provisional List of Flowering Plants and Ferns," by Rev. F. A. Rogers, published in Grahamstown in 1909. To this list it is now possible to add a considerable number of new records and corrections. Many of the new records have been established by Miss L. Britten of Rhodes University College.

Since my transfer from Grahamstown, Mr. C. D. B. Liebenberg, who was then stationed there, has made a detailed study of the vegetation of the south-western slopes of the Mountain Drive, Grahamstown. This area is covered by patches of *forest*, *bush*, *fynbos* and *grassveld*, but *karroid scrub* is absent. Partly for this reason and because it has received less attention from other authors, *karroid scrub* has been more fully dealt with in this account than the other formations. Further, I have restricted my attention almost exclusively to the

phanerogamic flora, although realising the importance of the part played by the cryptogamic flora.

The distribution of the various plant formations is governed mainly by climatic and habitat factors, in which geological formation appears to play a minor part. Soil-type apparently does affect the distribution of certain communities, particularly the comparatively shallow-rooted plants such as most grasses. Although somewhat casual observations have not established any marked correlation between geological formation and flora, this aspect might well be investigated more closely with interesting results. Up to very recent times the lack of a precise knowledge of the geological boundaries was a serious obstacle. This state, however, has been remedied during the past few years by the work of E. D. Mountain, Professor of Geology, Rhodes University College, Grahamstown, to whom I am very grateful for the chapter on the Topography and Geology of the area, illustrated by two maps prepared by him. The map relating to the Geology is very largely the result of personal investigations during which many inaccuracies in older maps have been corrected. In soliciting Professor Mountain's co-operation I considered it preferable that he should state the facts of his recent discoveries, rather than that I should compile an account chiefly from old and imperfect records. Professor Mountain has also supplied the map showing the rainfall isohyets.

To Dr. S. Schonland I owe a great deal, including my introduction, both in the field and in the herbarium, to this vastly interesting flora. For the use of the resources of the herbarium and library at Kew, I am greatly indebted to the Director, Sir Arthur Hill, and members of his staff, particularly Dr. J. Hutchinson, who was, at all times, willing to advise on the finer points of taxonomy. Further, this opportunity is taken of expressing my sincere appreciation of encouragement during this work from the Chief, Division of Plant Industry, Dr. I. B. Pole Evans, C.M.G. ; the Principal Botanist, Dr. E. P. Phillips ; the Director of the Albany Museum, Dr. J. Hewitt ; and Principal J. W. Bews, whose interest since my student days has always been inspiring. Finally I wish to acknowledge the very helpful and untiring assistance in routine work of Miss Grace Britten.

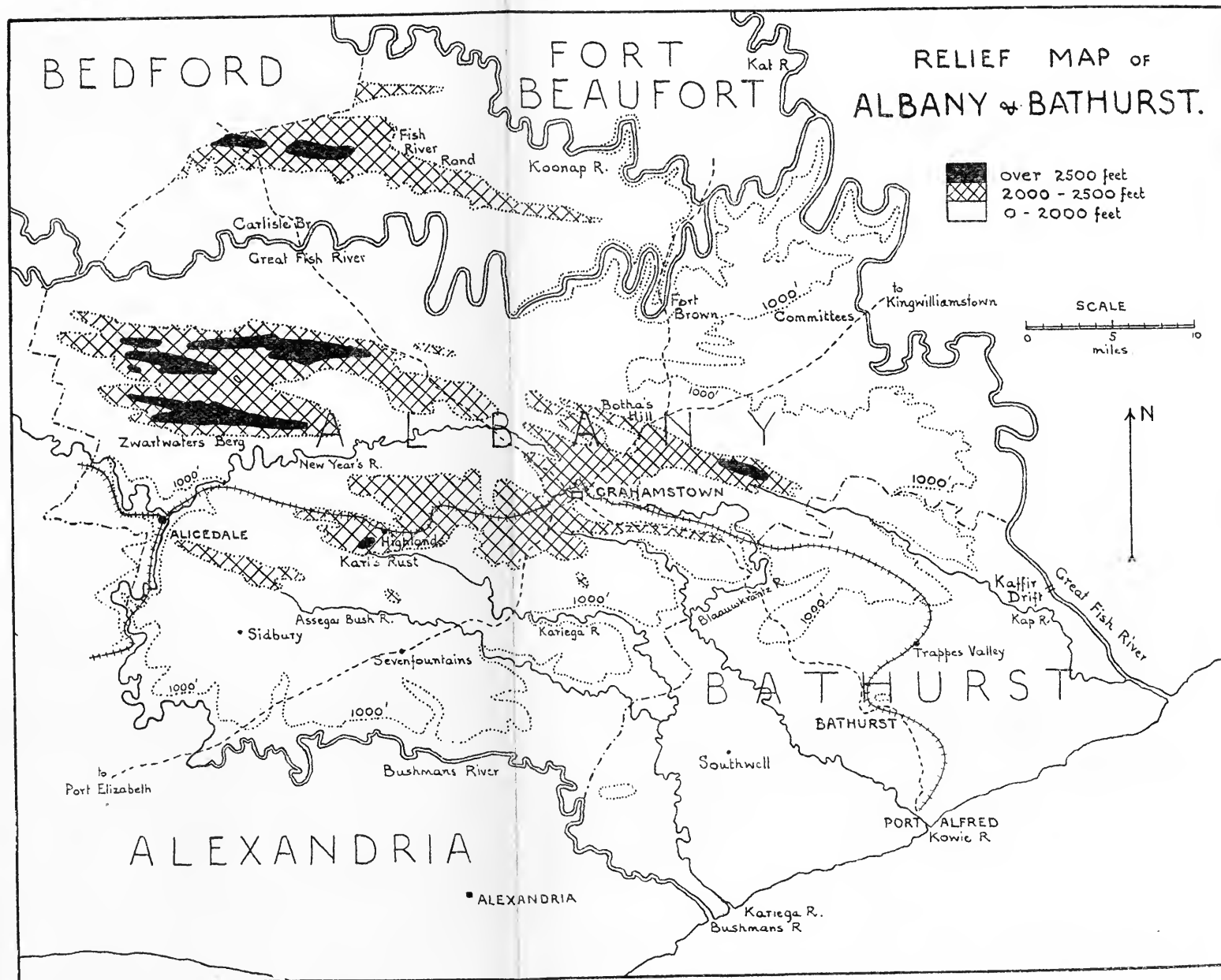
## THE VEGETATION OF THE DIVISIONS OF ALBANY AND BATHURST.

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## Chapter 1.

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EARLY BOTANICAL EXPLORATION :  
THE FOUNDATION AND DEVELOPMENT OF THE  
ALBANY MUSEUM HERBARIUM.

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## CHAPTER I.

## EARLY BOTANICAL EXPLORATION.

Before introducing the reader to the pioneers of botanical exploration in the area under consideration, it may be helpful to mention very briefly certain events at the "Cape of Good Hope" which led to the gradual penetration of the "dark interior."

The first white settlement at the Cape was established in 1652, under the command of Jan van Riebeeck, who had been sent out by the Dutch East India Company with the object of supplying their vessels with fresh vegetables and meat on the voyages to and from the East Indies. The small band of Hollanders were given instructions to confine their activities to a limited area in the neighbourhood of the Cape. It was not long, however, before the more adventurous spirits moved farther inland in search of new pastures for their stock, and organised expeditions into the interior soon followed. By the close of the 17th century many botanical specimens and seeds had been sent to Holland through the agency of the two Governors, W. A. and Adrian van der Stel, father and son, who organised special expeditions with this object in view. As a result of this, Commelin published his "*Praeludia*" in 1700, containing figures of various South African succulents, some of which are recorded only from the eastern Cape Province. Until that time the only aborigines met with were either Hottentots or Bushmen, and it was not until early in the 18th century that "Kaffirs" were encountered by expeditions penetrating eastwards beyond the Great Fish River, in the region of the Keiskama River and Amatola Mountains. At that period the minor "Kaffir" tribes were migrating south-west from Natal under pressure from the Zulus. Thus about the time of the founding of the settlement at the Cape, the area of Albany and Bathurst was little more than a wild game sanctuary. It was soon to become the scene of conflict between white and black races and for this reason botanical exploration in the eastern Cape Province was retarded for more than a century.

Carl Peter Thunberg, a Swede, frequently styled the "Father of South African Botany," arrived at the Cape in 1772. On one occasion, in company with Francis Masson, a gardener from Kew, he made a botanical excursion as far east as "Kuka" (Coega) in the Sunday's River valley, where the party arrived during December, 1773. Many species found in this area are also present in the adjacent area of Albany and Bathurst, but Thunberg did not penetrate quite so far east. In his narrative Thunberg refers to the murder by natives of a farmer, Heupnaer, for the sake of the iron on the wheels of his waggon, which indicates that hostile natives were one of the main perils early travellers had to face. This took place during a journey to the "Caffres and Tambukki" and he mentions also the Great Fish River, now the eastern boundary of Albany and Bathurst. In Thunberg's time the area east of the Gamtoos River was referred to as Kaffraria and "out of bounds" to colonists, but it is certain that many, including the noted leader Kock, made private expeditions into the forbidden country for big game hunting and to collect salt at Zwartkops.

Francis Masson, the Kew gardener mentioned above, was sent out in 1773 by Sir Joseph Banks on behalf of King George III, known as "Farmer George,"

and he soon began sending back extensive collections of living plants, seeds and dried specimens. Many of these he collected in the eastern Cape Province, while in the company of Carl Thunberg.

Another Swede, Andrew Sparrman, paid more attention to zoology than to botany, but made many interesting observations on the vegetation of the Cape in his book "A Voyage to the Cape and round the World." He arrived at Zwartkops River in December, 1775, and from there pushed on to Bushman's River, entering Albany in the direction of Assegai-bosch which takes its name from the common name of the tree *Curtisia faginea* Ait. The author states that the district round about was "of the kind called sour." Thence moving north he reached "Quammedacka" (Commadagga) and saw springboks travelling in herds of several thousands, and "all the plants round about (except the succulent ones) were dried up like hay" and "the veld just like the road" and temperatures of 100 not infrequent. There is a further passage which bears quotation "if one travelled from the upper part of the Visch (Fish) River more to the south-east of the eaffre side of the country one would come to a river called Konap" (a tributary of the Great Fish River) "and further east Kaisi kamma (Keiskama) River, which derives its source from a mountain known to the colonists by the name of Bambus-berg or Bamboo-mtn. from the circumstance of a sort of reed or bamboo growing upon it, which was very much prized by them for the purpose of making handles for their long whips." The bamboo, *Arundinaria tessellata* Munro is found mainly on the southern spurs of the Drakensberg.

In the preface to his book "Travels in Africa", 1777-79, Lieutenant Paterson claims to have been the first white traveller to enter Kaffraria, which, at that date, was the country east of the Bushman's River, including Bathurst. Although this statement is obviously incorrect, he may well have been the first botanical collector to cross the Great Fish River. It is most regrettable that the many specimens he collected on this track cannot be traced at the present time. Of Alexandria division, adjoining Bathurst on the western boundary, Paterson remarks "extremely beautiful and picturesque, very hilly and the hills are shaded with impenetrable woods; the valleys are well watered and covered with grass . . . great numbers of quadrupeds, Lions, Panthers, Elephants, Rhinoceros, Buffaloes, Springboks," etc. Later when travelling in Bathurst towards the Fish River, Paterson mentions discovering a *Leucadendron* sp.,\* quite probably referring to *Leucospermum ellipticum* R. Br. which, to this day, is a feature of beauty in those parts, and a palm, probably *Phoenix reclinata* Jacq. in the type locality, "and many other beautiful plants." He made his way to the Fish River about 20 miles from the mouth and experienced great difficulty in penetrating the karroid scrub "thickets" until he entered an elephant-track. In the river Hippopotami were encountered. He found the natives not unfriendly at this time and was permitted to advance through the "beautiful and fertile" country as far as the Keiskama River before retracing his steps.

W. J. Burchell, Botanist, Zoologist, Entomologist, was probably the best equipped scientist of early times to arrive at the Cape, and did so at the end of 1810, 38 years after Thunberg. It is a great loss to science that the publication of his diary "Travels in the Interior of South Africa" remains incomplete. Fortunately, however, his personal set of botanical specimens and catalogues are now preserved at the Royal Botanic Gardens, Kew, England. From these records we learn that Burchell entered Albany by the Commadagga Road about

\* In those days the names *Leucadendron* and *Leucospermum* were often confused.

the 7th July, 1813, by which time he had collected and catalogued 3,354 botanical specimens, excluding seeds and bulbs. He made his way via Zwartwater Poort to Riebeek East, and thence to Grahamstown, having added a further 174 specimens to his collection and made other scientific records. After a few excursions in the vicinity of Grahamstown, he left by the familiar Kowie East road and branched off at Blaauwkrantz towards Kaffir Drift and the Fish River mouth. From the Fish River mouth he retraced his steps to Kaffir Drift before continuing to the Kowie River and Port Alfred. Attracted by the country he returned to Kaffir Drift and Blaauwkrantz before trekking on to Kasouga, Rietfontein, Barville Park, Theopolis, Assegaibos, Sidbury and Rautenbach's Drift on the Bushman's River, and thence into Alexandria at the beginning of November. By this time Burchell had collected 852 botanical specimens in our area and very few species were collected more than once or twice. When he left the Cape in 1815, after less than five years exploring, Burchell's herbarium specimens numbered over 8,750, besides which he had amassed extensive zoological and entomological collections. Systematic treatment of many of Burchell's novelties was forestalled by the early publication of descriptions of specimens collected by Ecklon and Zeyher, and Drège about 15 to 20 years after Burchell's time.

Zeyher (1822) and Ecklon (1823), two Germans, arrived at the Cape independently, with the object of collecting botanical specimens for sale in Europe, and were pleased to join forces in 1829. They collected most extensively in the Uitenhage area and, during one or two joint excursions, specimens were gathered in Albany and Bathurst. In 1839-1840 Zeyher joined the zoologist Burke on his historic expedition to the Magaliesbergen. On their way north from Port Elizabeth they passed through Howiesons Poort to Grahamstown, and thence via Hell Poort to Cradock, collecting many specimens en route.

In 1826 J. F. Drège arrived at the Cape and collected with much greater system and scientific insight than his predecessors, Burchell excepted. He was at least the first to group the flora into vegetative regions. For some time after his arrival he concentrated his attention on the south-western Cape and Karroo areas, and it was not until late in 1829 that he passed through Albany for the first time. In 1831 he joined the celebrated zoologist, Dr. Andrew Smith, on a collecting trip through the eastern Cape Province to Natal. He returned alone along the same route, and after collecting in Albany, Bathurst and Uitenhage, he set off to Queenstown and by a long detour arrived at the Cape. By this time he had collected the colossal number of 200,000 specimens, representing 8,000 species, but comparatively few of these were from our area.

Among other early travellers to enter the area were the two Viennese gardeners, Boos and Scholl, who collected the type material of *Phoenix reclinata* Jacq., and Bowie, from Kew, while Le Vaillant and Lichtenstein had less contact. Later came T. Cooper, W. Tyson and Miss F. Bowker.

Thomas Cooper came out to South Africa soon after 1860 to collect plants for cultivation in Mr. W. W. Sanders' garden at Reigate, England. It was through contact with succulents collected by Cooper that the late Dr. N. E. Brown first received the stimulus for studying these plants, and his monographs of the *Stapelieae* and genus *Euphorbia* in the Flora Capensis are examples of his finest work. W. Tyson collected extensively near Port Alfred during the latter part of the 19th century and duplicates of most of his specimens are in the Albany Museum and the National Herbarium, Pretoria. During this period also, P. MacOwan made a very thorough collection of the flora and his work will be referred to again.



Mrs. F. Barber (née Bowker) collected widely in the eastern Cape Province and many of her specimens came from near Kowie. Unfortunately they were not always accurately labelled, and, in consequence, some which almost certainly came from the Bathurst coast, bear the locality Somerset East, due very probably to the fact that they were posted to the Royal Botanic Gardens, Kew, from that town. A similar mistake occurred with a parcel of specimens collected by Dr. W. G. Atherstone in Bechuanaland and Transvaal and posted from Grahamstown. Other collectors are mentioned in the following account of the History and Development of the Albany Museum Herbarium.

## HISTORY AND DEVELOPMENT OF THE ALBANY MUSEUM HERBARIUM.

Prior to the year 1889, when Dr. Selmar Schonland became Curator of the Albany Museum, there was only the merest nucleus of a botanical collection consisting of less than 1,000 sheets. In that year Dr. W. G. Atherstone presented the whole of his valuable herbarium to the Museum and very shortly afterwards Prof. Peter MacOwan made important contributions of pressed plants. This period therefore may be taken as the starting point of the Herbarium as an active institution. The Herbarium benefited further from the generosity of MacOwan by the donation of a very large number of valuable specimens collected by earlier botanists, among which were included a very fine set of Ecklon and Zeyher duplicates. The late Dr. H. Bolus, Dr. T. R. Sim, Dr. E. E. Galpin and H. G. Flanagan were also active contributors at this early period. Mrs. G. White and Mrs. H. Hutton also started collecting extensively for the Herbarium. A residue of Mrs. F. Barber's collection was presented by her.

MacOwan continued his contributions for many years and in the year 1904 the MacOwan collection was still further increased by the incorporation of the Gill College Herbarium, Somerset East, which had been built up by MacOwan when he was a member of the staff of Gill College. It is quite probable, therefore, that the MacOwan collection is more complete here than in any other institution, although many of his specimens perished at Somerset East after he left. In 1904 Dr. Schonland reported:—

"In the year 1889 Prof. MacOwan presented to the Trustees of Gill College, Somerset East, a large Herbarium which at the time was the most extensive and the only General Herbarium in South Africa. It was considerably added to by the donor during the remainder of his stay in Somerset East as Principal of the College (to the year 1881). Since that time it has been lying practically unused and there was no chance of its ever being utilized properly in Somerset East and as, unless constantly cared for, it was bound to become a prey to injurious insects, the Trustees, with the consent of Professor MacOwan, wisely decided to offer it to a more active scientific centre. This offer was gratefully accepted by the Director of the Albany Museum on behalf of that institution, and a few days ago it was removed to Grahamstown under his supervision. Hitherto only a portion of the collection, which probably consists of about 15,000 specimens, has been carefully examined and fortunately the damage seems to be confined to a certain natural order (e.g. Compositae) but does not seem to be very great as yet. The collection will be incorporated with the Albany Museum Herbarium which, already very extensive, will thus become second to none in South Africa.

The following abstract from a circular issued by Prof. MacOwan in Jan., 1870, will give an idea of the value of the collection :—

The chief contributions have been from :—

Dr. J. D. Hooker, F.R.S. Director of the Royal Botanic Gardens, Kew.

Dr. D. Oliver, F.R.S. Keeper of the Kew Herbarium.

Dr. H. S. Reichenbach, F.R.S. Director of Botanic Gardens, Hamburg.

Dr. W. Sonder, Hamburg.

Dr. Th. Orphanides, Athens, Kingdom of Greece.

Dr. Osw. Heer, University of Zurich.

Dr. Hance, H.B.M. Consulate, Whampoa, S. China.

Dr. Asa Gray, F.R.S. Harvard College, Cambridge, U.S.A.

Prof. D. C. Eaton, Yale College, Newhaven, U.S.A.

Dr. Bolander, San Francisco, California, U.S.A.

Dr. Ferd V. Mueller, F.R.S. Melbourne, Victoria.

His Excellency Sir H. Barkly, K.C.B. Port Louis, Mauritius.

His Excellency Sir Wm. Munro, K.C.B. Barbados, W.I.

The Cape section of the Herbarium contains about 700 of Burchell's plants, collected in 1812-14; many from Ecklon and Zeyher, Drège and others—the more recent very extensive sets from H. Bolus, Esq., and of Graaff Reinet; others from Kennedy, Atherstone, Bowker, Sanderson, Murray and all MacOwan's collections since 1862. It may be considered nearly complete as regards the flora of Albany, Graaff Reinet and Somerset East. The American section, by the continued care of Dr. Asa Gray, is approximately complete with reference to the N. Atlantic States. It contains Oak's, Tuckerman's and Mann's New Hampshire and Massachusetts collections, Sullivant's Ohio and Lapham's Wisconsin plants, Hall and Beggs Illinois, Eaton's New Jersey and Canby's Delaware and Florida collections. Of the Pacific States Flora there are Bolander's fine Californian sets, with a few of Dr. Kellogg's from the same district, Eaton's Nebraska and Kansas plants. From the Rocky Mountains is a nearly complete series of Hall's collections, and some of Drummond's. Lastly, imperfect sets of Lindheimer's and Fendler's Neomexicanae.

From Continental India are sets of Falconer's Kumaun and Bengal collections. From Peninsular India is a valuable set of Wight's Herbarium amounting to nearly 1,200 species; from Australia, a large series from Dr. F. V. Mueller; from St. Helena all Melliss's excellent collection—from Brazil, two centuries of Dr. Burchell's plants, a small set of Abyssinians from Dr. Schimper and a nearly complete series of Mauritian ferns from His Excellency, Sir H. Barkly, K.C.B.

In course of exchange there are now due: Hance's Southern Chinese Flora, Orphanides' Flora Græca Exsiccata, Wright's Cuban collections, Phillip's Chilean Herbarium (from Dr. Heer) and North European collections from Drs. Sonder and Reichenbach.

Some of the latter were received, as well as many other fine sets, among which we noticed about 1,600 species of Fungi from Thumen's 'Mycotheca Universalis.'

We congratulate the Museum authorities on this valuable addition. Dr. MacOwan, after his retirement, spent a couple of years re-arranging the Somerset East collection."

From 1889 up to June, 1926, Dr. S. Schonland was most active in building up the collections, and considering that very little time could be spared from other duties and that it was never possible to spend much money in the purchase of specimens, nor in collecting, the progress of the Herbarium has been very satisfactory. When the present Director, Dr. J. Hewitt arrived in 1910 he found the Herbarium was scattered over various small rooms. In the year 1920 an enlargement of the building made it possible to devote to this purpose the spacious hall it now occupies. Office room was also provided.

As mentioned above, Dr. Ernest Galpin contributed a large amount of material and when he presented his whole collection to the Union Government, with his consent, Dr. I. B. Pole Evans allowed such numbers from the duplicates as were not represented in the Albany Museum to be transferred to it. The Galpin collection, therefore, as to the earlier numbers, is second only in importance to that of the National Herbarium. Medley Wood and Miss Alice Pegler also made useful contributions. Within recent years collections made locally by A. Glass and by I. L. Drège, near Port Elizabeth, have been received from the trustees of their respective estates.

The value of the collection is considerably enhanced by the inclusion (by purchase) of one of the most complete sets of R. Schlechter's duplicates, containing many cotype numbers. Other specimens purchased were W. Tyson's seaweeds and some of Dinter's early numbers from S.W.Africa.

Of the present generation, Miss L. Britten, of Rhodes University College, has contributed largely in connection with her ecological studies of the local flora. Large additions have also been received from Mrs. T. V. Paterson, Dr. H. G. Fourcade, F. A. Rogers, Dr. G. Rattray, Mr. F. Cruden, Misses Daly and Sole, Adams and the writer. Many other collectors have contributed to a lesser degree.

The Cryptogamic section contains a large number of ferns collected by T. R. Sim and Lady Barkley, a useful representation of South African mosses from Miss Farquhar and Rehmann, and many seaweeds contributed by H. Becker.

The South African collection of flowering plants, which now must number in the vicinity of 100,000 specimens, is arranged, as far as families and most of the genera are concerned, according to Durand, and the species are classified mainly on the *Flora Capensis* of Harvey and Sonder and Thiselton-Dyer. Where later revisions of genera have proved satisfactory, the collection has been arranged accordingly.

When the Botanical Survey of South Africa was founded in 1917 the Albany Museum Herbarium was recognised as one of the Regional Herbaria. Up to this time the Herbarium had been maintained solely at the charge of the Albany Museum and for financial reasons it was not possible to appoint a fully qualified whole time botanist. From 1917 a small grant-in-aid has been received annually from the Provincial Council for the special benefit of the Herbarium, in recognition of the fact that it is the only representative herbarium in any public institution in the eastern Cape Province.

A new era in the history of the Herbarium began in 1925 when Dr. S. Schonland, a foundation member of the Botanical Survey Committee and Hon. Curator of the Albany Museum Herbarium, secured the appointment by the Union Government of a qualified botanist as his assistant. When about eighteen months later, Dr. Schonland retired from active survey work, the Botanical Survey officer was placed in charge and was appointed Hon. Curator of the Herbarium by the Board of Trustees of the Albany Museum. The writer was the first Government Botanist to hold the post and on his temporary transfer to the Royal Botanic Gardens, Kew, in 1930-31, Mr. C. D. B. Liebenberg was appointed from the National Herbarium, Pretoria. Miss G. Britten, after serving a number of years as temporary lay assistant to Dr. Schonland, received a permanent appointment under the Botanical Survey in 1931.

The Trustees of the Albany Museum have pursued an enlightened policy, encouraging the use of the Herbarium for the education of students and the general advancement of botanical science.



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## Chapter 2.

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TOPOGRAPHY AND GEOLOGY, by Edgar D. Mountain,  
M.A., Professor of Geology Rhodes University College,  
Grahamstown. (2 Maps.)

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## CHAPTER 2.

## TOPOGRAPHY AND GEOLOGY OF ALBANY AND BATHURST

BY

EDGAR D. MOUNTAIN, M.A., Professor of Geology, Rhodes University College,  
Grahamstown.

The Divisions of Albany and Bathurst together cover a somewhat rounded area some 2,300 square miles in extent, the maximum dimensions being approximately 60 miles east-west and 50 miles north-south, and largely occupy the northern half of the area included between  $26^{\circ}$  and  $27^{\circ}$  east longitude and  $33^{\circ}$  and  $34^{\circ}$  south latitude. The Division of Bathurst, situated in the south-east coastal portion of the area concerned, accounts for about two-ninths of the whole area, and possesses a little over 30 miles of coast-line.

The Bushman's River from Alicedale to its mouth forms to the south a natural boundary to the area, separating it from the Division of Alexandria. To the north of Alicedale the boundary runs across country to the confluence of the Great and Little Fish Rivers dividing Albany and Somerset East, and from there it turns to the north-east to the big bend in the Koonap River thus separating Albany from Bedford. The rest of the boundary is a natural one following the Koonap River to its junction with the Great Fish River and then the latter river to the sea. This part of the boundary separates the area to be described from the Divisions of Fort Beaufort, Victoria East and Peddie. Finally, the remainder of the area is bordered by the sea, so that it will be observed that the greater part of the region possesses natural boundaries.

The area is one of considerably diversified relief. Rising from sea-level in the south-east it reaches a maximum altitude of 3,065 feet at the trigonometrical point Grootfontein just to the north of the village of Riebeeck East. Topographically the area may be divided into three regions, the Fish River valley to the north, a tract of ridges and valleys in the centre, and a peneplaned coastal belt. The central part of the area consists of a series of sub-parallel mountain-ranges running roughly E.S.E., which includes an unnamed range passing through the point just mentioned; another range just south of Riebeeck which rises to a height of 3,013 feet above sea-level at the beacon Riebeeck and which is known as the Zwartwaterberg; a third range culminating in Karl's Rust (2,734 feet) which passes just south of Grahamstown; and finally the Botha's Hill ridge to the north of Grahamstown which rises to 2,782 feet at Driver's Hill and divides towards the east into the Frazer's Camp ridge and the Cap (or Kap) River Heights, in Albany and Bathurst respectively. It seems curious that many of the elevated areas possess no local names and the names shown on old maps frequently no longer apply.

To the north of the Grootfontein range and the almost aligned Botha's Hill-Frazer's Camp range, the altitude drops into the broad valley of the Great Fish River to below 1,000 feet, while in the region between the Great Fish and Koonap Rivers the altitude rises again to a well-defined plateau known as the



Fish River Rand at an elevation of some 2,400 feet above sea-level. In the east, the various ridges drop down towards the Fish River valley and pass insensibly into peneplains before the present valley is reached. Here the river flows through a valley only a mile or so in width cut into a peneplain about 800 feet above sea-level which apparently corresponds to a well-defined coastal plateau of the Eastern Province. This feature is particularly well seen in the vicinity of Kaffir Drift.

South of the range through Karl's Rust, the topography is seen to consist of a series of dissected peneplains gradually dropping in elevation towards the south. Perhaps the most conspicuous of these are the Salem Flats between Salem and Sevenfountains at 1,300 to 1,400 feet, the Martindale Flats which slope towards the coast and from which rises the well-known Round Hill at about 1,000 feet, the peneplain east of Bathurst at 750 to 800 feet, and lastly a lower coastal peneplain north of Port Alfred at about 350 feet. These peneplains themselves are generally not horizontal, but usually have a slope of a degree or two towards the coast. The flats round about Sevenfountains may be regarded structurally as the eastern continuation of the Zuurberg range which, in common with the coastal region generally, has been so modified by peneplanation here that it no longer forms a conspicuous feature. On the other hand, the series of parallel ranges immediately to the north may conveniently be regarded as members of the Zuurberg system, since they are directly linked up topographically and structurally with the Zuurberg and belong to the same set of folded strata.

Another very conspicuous peneplain partially encircles the city of Grahamstown on its northern side, where it is situated at an elevation of 2,100 feet and is known as the Racecourse or Aerodrome Flats. This feature is extraordinarily flat and provides a most striking sky-line from the city. Further north still, remnants of a peneplain at about 1,900 feet can be observed along the southern margin of the Fish River valley just to the north of Collingham Tower and Driver's Hill, and beyond the Fish River is the Fish River Rand already mentioned.

The northern part of the area lies in the drainage basin of the Great Fish River and its tributaries. Except for the fifteen miles or so immediately above its mouth, the river follows a most extraordinarily meandering course and with the exception of the stretch below Hunt's Drift, the river runs in a broad valley singularly deficient in anything like extensive flood-terraces. The river thus occupies entrenched meanders, the banks of which have generally been eroded down to fairly moderate gradients. The only important tributary flowing through the area is the Cap (or Kap) River which rises near Driver's Hill and flows through a steep and attractive valley to join the Fish River almost at the mouth of the latter.

The Bushman's River also possesses a highly meandering course and is joined at Alicedale by the New Year's River which rises near Grahamstown and in places winds through very precipitous gorges. South of Grahamstown the country is drained to the south by a number of rivers flowing independently to the sea, chief of which are the Kariega with its tributary the Assegai Bush River, and the Kowie which is known in its upper reaches as the Blaauwkrantz. These rivers are also deeply entrenched and meandering to a smaller extent, and possess a property shared by the Bushman's River, a tidal estuary. Indeed, the last-named is said to be tidal for a distance of 25 river miles, while the Kariega is tidal for about 10 miles and the Kowie for about 12 to the famous Horse Shoe Bend, providing a magnificent and attractive stretch of water.

In somewhat striking contrast to these conditions, the Great Fish River is tidal for only three or four miles, a feature which is presumably ascribable to the heavy silting which the lower reaches of this river experience.

Geologically, the region is situated along the northern margin of the Cape Fold Belt at its eastern extremity where it disappears beneath the waters of the Indian Ocean. The three-fold topographical subdivision of the region has its counterpart to some extent in the geological structure. For instance, the Fish River valley is carved out of beds of the Karroo System which have been only slightly involved in the Cape foldings, while the central region of mountain-ranges shows typical folding about an approximately east-west axis with frequent pitching. The southern region characterised by peneplanation consists structurally of a similar series of folds which have been truncated by peneplaned surfaces which still carry post-Cretaceous deposits over wide areas.

The accompanying map shows the distribution of geological formations. They have been taken partly from the Geological Survey Cape Sheet No. 9 with minor modifications and generalisations, while the half east of Grahamstown is the result of the author's work alone. As will be seen, the outcrops belong largely to members of the Cape and Karroo Systems.

The oldest rocks in the region, the Bokkeveld Series, consist largely of shales, sometimes micaceous, and thin-bedded sandstones, mostly rather dark in colour, and occupy a large part of the basins of the Kariëga and Kowie Rivers. The outcrops are usually rather weathered giving rise to a reddish clayey soil, and are generally fairly well covered with bush.

The Bokkeveld Series is overlain by the Witteberg Series which is composed essentially of fairly massive quartzitic sandstones with very subordinate micaceous and carbonaceous intercalated shales. When fresh, these sandstones are pale-grey in colour but frequently stand out quite white in the form of *krantz*s. The Witteberg Quartzites form the series of mountain ranges in the central portion of the area and also the greater part of the peneplaned district of the south, being naturally exposed in magnificent *krantz*s where they are traversed by the New Year's, Kariëga and Blaauwkrantz Rivers. They generally give rise on weathering to a grey sandy soil, although sometimes locally blackened under *vlei* conditions. A considerable thickness of shales occurs near the top of the series in some parts, and owing to the thinning out of the topmost quartzite, the upper limit of the series is sometimes difficult to define. Moreover, there are extensive outcrops of shale on Rokeby Park and Komgha Mouth along the Port Elizabeth-Grahamstown road near the Bushman's River which, though mapped as Witteberg, may prove to belong to the Bokkeveld series. These shales give rise to reddish and brownish clayey soils frequently containing patches of calcareous tufa.

The Dwyka Series which follows the Witteberg Series is sub-divided into the Lower Shales, the Tillite, and the Upper Shales. The Lower Shales are very similar in appearance to the Bokkeveld Series but also comprise in their upper half quite a considerable thickness of dark sandstones usually distinguishable with ease from the sandstones of the Witteberg Series. The Tillite, usually characterised in outcrop by a lenticular form due to weathering as typified in the Grahamstown location where the weathered-out blocks are known as Bushman tombstones, is easily recognised even in highly weathered outcrops by the pebbles, mostly of quartzite and gneiss, which are irregularly scattered through a fine unbedded matrix. This peculiar rock is well exposed along the shore at the first headland half a mile or so west of the Fish River mouth. The

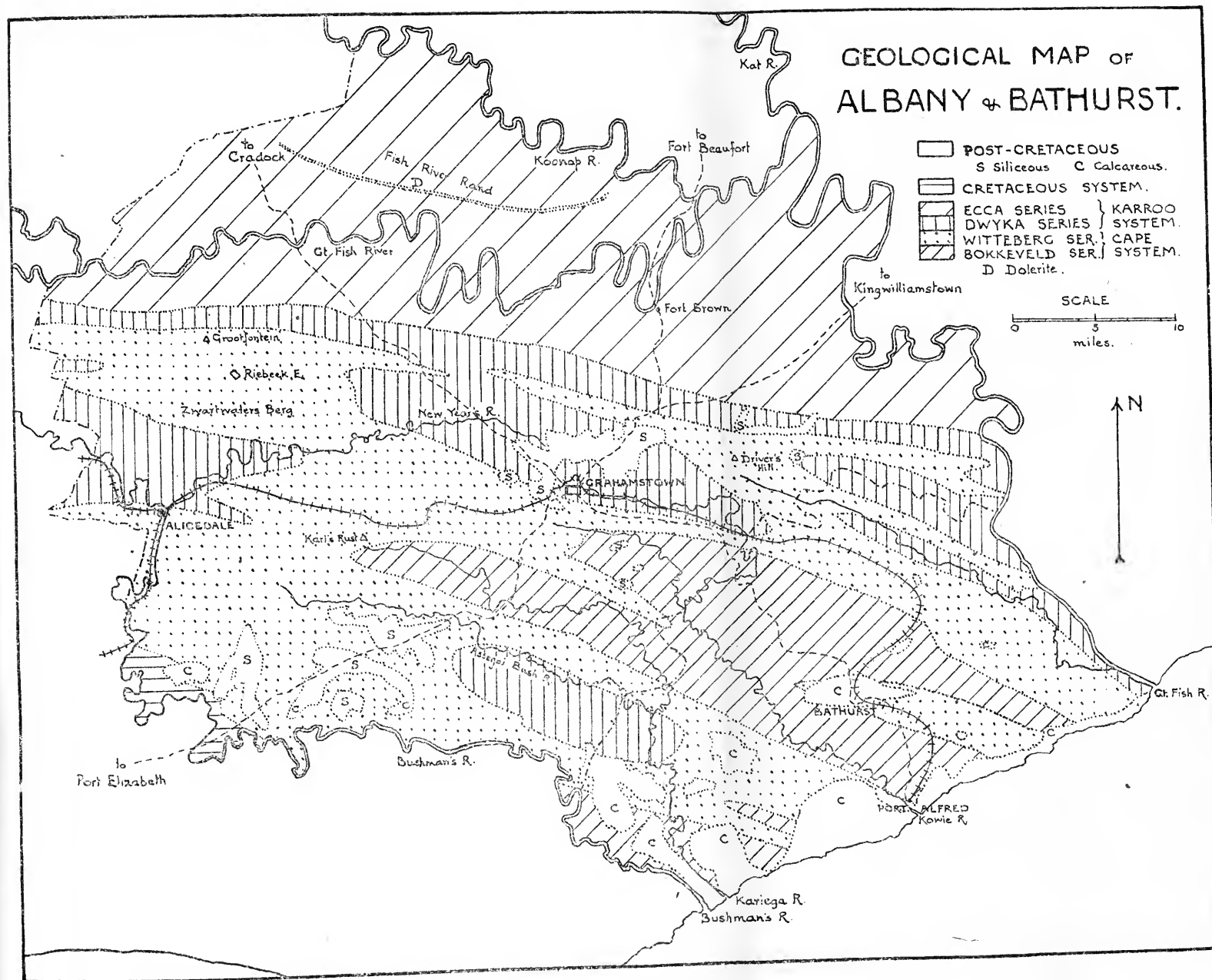
Upper Shales occupy an insignificant area in the form of a narrow strip separating the Tillite from the succeeding Ecce Series, and in places carry at their top a characteristic band of chert a few inches thick. All the members of the Dwyka Series give rise to brownish and reddish clayey soils, becoming progressively more drab in colour with increased distance from the sea, due presumably to diminished rainfall. In the vicinity of Grahamstown, the Lower Shales have been weathered to an extraordinary extent and locally bleached to a white clay. On the whole, the Dwyka Series forms low-lying land in the valleys of the New Year's, Assegai Bush, Kap and Blaauwkrantz Rivers and along the southern margin of the Fish River valley.

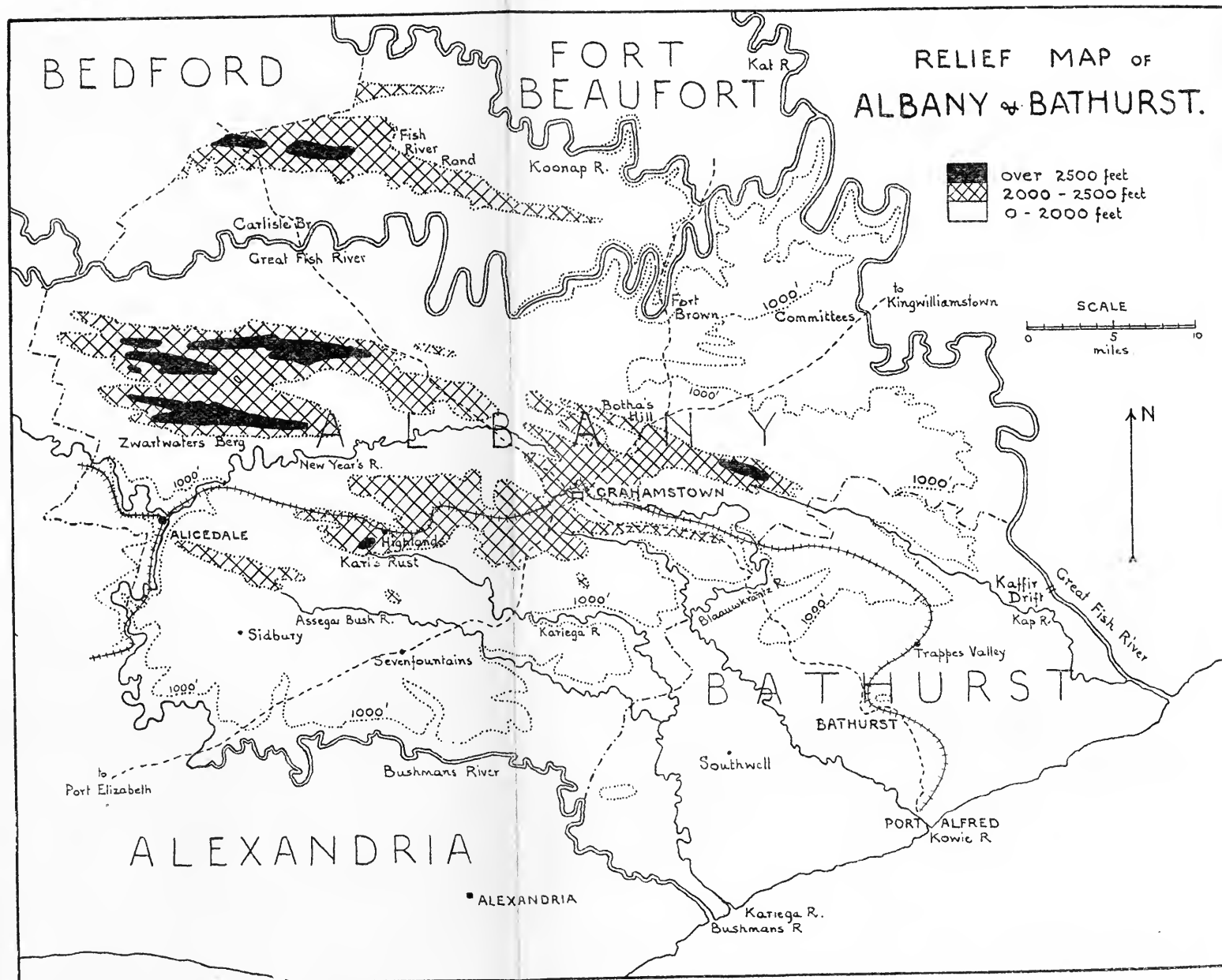
The Ecce Series, which succeeds the Dwyka Series, consists of shales of varying character interbedded with bluish sandstones and is found only in the Fish River valley, the beds dipping gently northwards. The soil is generally rather thin, drab and loamy, and in places of particularly low rainfall there is evidence of lime-accretion. Invading this formation on the Fish River Rand there occurs a narrow dolerite dyke but this is distinctly south of the region where such dykes become common.

In the south-west part of the area where the Grahamstown-Port Elizabeth road crosses the Bushman's River is a small area of down-faulted Cretaceous rocks associated with a narrow strip of tuffs belonging to the Stormberg Series of the Karroo System. The Cretaceous rocks consist of clays and greenish sandstones, as exposed in the bed of the river by the bridge.

Formations deposited subsequently to the Cretaceous System are found only as thin outliers resting in isolated patches on the various peneplaned surfaces. The deposits in the Fish River valley to the north of Driver's Hill, those on the Grahamstown peneplain and those on the Salem Flats consist of surface quartzite or silexite, an extraordinarily compact and resistant material. It rarely exceeds thirty feet in thickness and usually carries a very thin covering of sour sandy soil. Nearer to the coast the deposits resting on the peneplains appear to be predominantly calcareous in nature. Although presumably a false-bedded calcareous sandstone originally, these latter deposits now consist largely, and especially at the surface, of spongy calcareous tufa. They are well exposed around Rokeby Park, near Southwell and in the neighbourhood of Bathurst, and are known as Alexandria or Bathurst Limestone. They give rise to typical grass-covered undulating topography, while shallow circular depressions, occasionally containing water, are common. Although these sandy limestones sometimes contain marine shells, the exposures furthest inland pass downwards into weathered Bokkeveld Shales and are evidently of terrestrial origin. These limestones moreover are frequently covered with a mantle of reddish clayey soil known as Olifants' Hock Clay presumed to be residual from solution of the limestone, though the overlying soil may also be grey or black sandy material.

Along the coast, the Cape and Karroo formations are obscured by unconsolidated coastal dunes and by dune-rock, which appear to pass further inland insensibly into the Alexandria Limestone. The dune-rock forms very attractive coastal scenery between the Bushman's and Kariega River mouths, and is also exposed along the coast at two points not far east of the Kasouga River mouth, and at the Three Sisters about 7 miles east of Port Alfred. Similar rocks are also found at the Fish River mouth but only on the Peddie bank. The rock is a calcareous sandstone and where weathered passes upwards into loose sand or calcareous tufa.





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## Chapter 3.

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### CLIMATIC AND SOME BIOTIC FACTORS :

Climate : Rainfall (Map and two Graphs).

Temperature.

Humidity.

Wind.

Light.

Some Biotic Factors : Fire.

Direct and Indirect Interference by man ;  
animals, etc.

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## CHAPTER 3.

## CLIMATIC AND SOME BIOTIC FACTORS.

## CLIMATE.

*Rainfall.*

The Divisions of Albany and Bathurst lie in the zone of approximately equal summer and winter rainfall. In some years the winter rainfall is slightly higher than the summer rainfall but usually there is a balance in favour of the summer period. Owing to the increased temperature during summer, however, the amount of effective moisture is definitely in favour of the winter period. Moreover, this is often augmented by excellent late summer rains in March, which have a carrying over effect well into the winter period. This is an important factor in the consideration of rainfall distribution throughout the year.

Owing to the moulding influence rainfall has on vegetation, a knowledge of rainfall data frequently makes it possible to visualise fairly accurately the type of vegetation likely to be met with in a particular area. It is, however, not so much the average yearly rainfall as the distribution throughout the year and the absolute maximum and absolute minimum rainfall which are the more important limiting factors in plant distribution. As a general rule perennials must be able to survive the severest drought and the period of highest rainfall. Many plants capable of flourishing in an area, given average rainfall conditions, might not be able to tolerate the absolute minimum or absolute maximum amounts. This aspect does not apply so forcibly to annuals, whose seeds are more often adapted to withstand such abnormal conditions.

As in most other parts of South Africa, the higher ridges and hills receive a greater rainfall than the lower valley levels. Rain clouds have an uninterrupted passage over the valleys, whereas they may come into contact with the higher altitudes and precipitate moisture either in the form of rain or mist. It follows, therefore, that the broad inland valleys of the Fish and Bushman's Rivers, more or less forming the north, east and west boundaries of this area, are drier than the intervening country. Rainfall records taken by Mr. J. Thomas at Rockcliffe, Sandflats, in the Bushman's River valley, and by Mr. A. T. Rivett Carnae at Brandeston, near Fort Brown in the Fish River valley, may be quoted in support of this (Table 3). On the other hand the rainfall at the coast and on the inland hills and mountains is appreciably higher. In these parts the rainfall averages from 20 to 30 ins. per annum, whereas in the valleys mentioned it diminishes to an average between 10 to 15 ins. Rains coming from the coast which may precipitate half an inch in Grahamstown are generally intercepted by Botha's Hill (Ridge), and the rainfall decreases greatly in the Fish River valley until at Committees, Fort Brown, etc., there may be none at all. Across the Fish River valley, in the vicinity of the hills near Breakfast Vlei and Fish River Rand, rainfall is again comparable with that in Grahamstown.

On the other hand parts of the Fish River valley benefit by occasional thunderstorms which miss Grahamstown and the coastal area. Coupled with the lower rainfall in the valleys is a generally higher temperature.



While one may obtain a very close approximation of the minimum rainfall areas owing to the location of the rain gauges near homesteads in the centre of valleys, records from places of assumed highest rainfall, on or near the tops of the mountains, are unobtainable for the simple reason that homesteads and scientific institutions are not built on these sites, but are placed in more protected positions. Parts of Grahamstown, except for a fraction more at Lombards Post, near Southwell, have the highest recorded average rainfall over a long period of years and it can be estimated with certainty that the higher south-western slopes of the adjacent mountains (Mountain Drive, etc.), receive a higher rainfall than Grahamstown by several inches. When weather conditions are obviously different in different localities, it is not to be expected that rainfall records will be the same. When conditions over a small area are apparently similar, however, one is led to expect the records to be more or less equal, yet, even in Grahamstown, the records taken at the gaol vary appreciably from those taken during the same period at the Government Veterinary office not half a mile distant, and records taken by Messrs. W. and C. Gowie on the other side of the town, about one and a half miles distant, give an intermediate average figure.

#### *Storms.*

Thunder storms are not a common occurrence in this area, particularly as compared with most inland parts of Natal. One to three fairly severe thunder storms per year over Grahamstown would be considered normal. Lightning and thunder storms accompanied by short heavy showers are more often, but not frequently experienced along the Fish River valley. *Hail* rarely plays any important part in the destruction of vegetation. *Floods*, when occasionally experienced, are due more to steady rainfall over a number of days rather than to an excessive amount in a short period. On the other hand the Fish River in particular may come down in flood through Albany, as it did in 1934-2 with disastrous results to bridges, due to abnormally heavy rains in the Karroo.

#### *Mists.*

In addition to the actual rainfall, plants in certain areas benefit by the condensation of moisture from mists. This applies to vegetation on the higher mountain slopes with a south or south-eastern aspect. Mists are blown inland from the sea at irregular times, mostly during summer months, and although the atmosphere is fairly heavily charged with moisture, this is not precipitated as rain when it strikes the mountain slopes. The great importance of the moisture collected by plants by condensation was demonstrated by Marloth on the Table Mountain, Capetown, during 1902-1903. More recent workers have had similar results in other parts of South Africa.

#### *Rainfall Records.*

Table 1 gives the rainfall normals up to the end of 1925, taken from the Report by the Director of Irrigation published in 1927. The figures are from stations scattered throughout the area and give a general idea of rain distribution. The periods over which results were available varied considerably and the averages cannot be used for detailed comparison. They serve to illustrate the fairly even distribution of rainfall throughout the summer and winter periods and the moderate average precipitation per rainy day. As pointed out previously, there are appreciable differences in rainfall within comparatively short distances and the averages illustrate this feature also.

*Table II* is interesting for the reason that the records for six stations in different parts have been taken over a comparatively lengthy period and a comparison should be made, especially between the figures for Alicedale in the Bushman's River valley (karroid scrub), those at Port Alfred (coastal scrub) and Grahamstown (inland bush and grassveld).

*Table III* gives the monthly rainfall totals and number of days rain at three selected stations, Rockcliffe (Mr. James Thomas) near Sandflats in the Bushman's River valley, Grahamstown Gaol, and at Brandeston (A. T. Rivett Carnac) near Fort Brown in the Fish River valley. The figures demonstrate very clearly the differences between the rainfall in the valleys as opposed to the amount on the mountainous area between. The great increase in the number of days on which rain falls on the hills as compared with the valleys is also significant. Here again it will be observed that excessive rainfall in a short period is very rarely experienced. Where the monthly total is comparatively high the number of days' rainfall is usually correspondingly higher.

*Graph I* gives the average rainfall distribution throughout the year for three stations, all showing a general similarity with March the peak Month, which, as pointed out previously, has a beneficial carrying over effect well into the winter period.

*Graph II* gives the percentage precipitation of the same three stations showing that a large percentage of rainfall is precipitated at a rate less than 1 ins. per day and only 5.5 per cent. to 13.5 per cent. is over 2 inches per day.

I am obliged to Mr. C. D. B. Liebenberg for the figures used in Graphs I and II.



TABLE I.

RAINFALL NORMALS UP TO THE END OF 1925.  
(Taken from the Meteorological Report, Department of Irrigation.)

Station.	Long. E.	Lat. S.	Alt.	Period.	Oct.	D.	Nov.	D.	Dec.	D.	Jan.	D.	Feb.	D.	Mar.	D.	Apr.	D.	May.	D.	Jun.	D.	Jul.	D.	Aug.	D.	Sept.	D.	Total for Year.	Total D.
Alicedale.....	26° 05'	33° 20'	905	44-46	1.62	4	1.80	4	1.43	4	1.44	4	1.33	4	1.72	5	1.45	4	1.34	3	0.88	3	0.78	2	0.94	3	1.13	4	15.50	44
Sydney's Hope.....	26° 10'	33° 24'	850	33-34	2.24	11	2.43	10	2.11	11	2.00	12	2.01	10	2.31	12	2.15	9	1.89	8	1.28	5	1.02	5	1.18	7	1.93	9	22.54	109
Atherstone.....	26° 25'	33° 19'	2263	44-45	2.25	9	2.37	8	2.23	8	2.20	9	2.21	8	2.47	9	2.00	7	1.72	6	1.08	4	0.99	4	1.12	6	1.91	7	22.55	85
Sunnyside.....	26° 30'	33° 17'	1850	17-20	2.74	9	2.95	8	2.71	10	1.42	7	2.54	9	2.83	9	1.83	6	1.75	5	1.29	4	0.92	3	0.73	5	1.79	7	23.49	82
Salem.....	26° 30'	33° 28'	500	30-31	2.14	7	2.47	7	2.04	6	1.72	6	1.79	6	2.24	7	2.07	7	1.48	5	1.26	3	0.99	3	1.38	5	2.02	6	21.60	68
Grahamstown (V.R.O.).....	26° 32'	33° 18'	1700	5-6	1.33	7	3.81	8	2.18	11	2.11	9	1.76	7	2.64	10	2.33	9	1.42	7	1.65	5	1.61	3	0.72	4	1.66	7	23.22	87
„ (Gaol).....	26° 32'	33° 18'	1700	47-49	2.95	9	3.25	9	2.55	8	2.56	9	2.73	9	3.20	10	2.36	8	2.04	6	1.44	4	1.22	4	1.50	6	2.41	7	28.21	89
„ (Hospital).....	26° 32'	33° 20'	1851	14-16	2.73	9	3.51	9	2.47	7	2.50	9	2.83	8	3.34	8	2.28	8	2.35	7	1.06	3	0.94	5	1.77	6	2.56	7	28.34	86
Heatherton Towers.....	26° 34'	33° 09'	900	18-19	1.44	4	1.16	3	1.34	4	1.34	3	1.56	4	1.59	4	1.57	4	0.94	3	0.74	2	0.30	2	0.46	2	1.23	4	13.67	39
Brandeston.....	26° 36'	33° 07'	1000	5-7	1.17	4	0.93	4	1.35	3	2.26	4	2.75	5	2.05	4	0.91	2	1.91	2	0.99	2	0.39	1	0.56	3	1.27	3	16.54	37
Uplands.....	26° 36'	33° 09'	—	7-8	0.53	2	1.79	4	1.08	4	1.17	4	1.61	6	1.96	5	1.34	4	0.52	2	0.63	2	0.65	2	0.33	2	0.74	2	12.35	39
Lombard's Post.....	26° 42'	33° 33'	—	7-10	2.03	8	3.68	10	2.73	10	2.47	10	2.08	9	3.15	11	2.53	9	2.33	8	2.00	6	1.61	6	1.49	7	2.26	8	28.36	102
Fraser's Camp.....	26° 50'	33° 16'	1750	10-12	1.50	4	2.84	4	2.12	6	2.00	6	1.60	5	2.51	5	1.64	4	1.27	3	1.03	2	1.18	2	0.64	2	1.26	3	19.59	46
Bathurst.....	26° 50'	33° 30'	—	8 9	2.11	8	4.01	6	2.60	7	2.13	8	1.92	6	3.15	8	2.16	5	2.09	5	1.63	3	1.74	3	0.89	4	2.40	6	26.83	69
Port Alfred.....	26° 54'	33° 34'	200	43-45	2.41	8	2.58	7	2.06	7	1.59	7	1.67	7	2.02	8	2.20	7	2.14	6	1.59	5	1.41	5	1.77	6	2.46	7	23.90	80
Cuylerville.....	27° 02'	33° 31'	300	4-5	2.13	9	1.48	8	2.93	8	1.91	7	1.36	8	1.46	7	1.28	6	1.06	4	1.35	4	1.17	4	1.61	6	2.11	8	19.85	79
Great Fish Point.....	27° 06'	33° 31'	240	8-9	1.69	7	3.75	8	2.21	9	2.29	9	1.95	8	2.68	9	2.49	9	2.00	8	1.60	5	1.42	5	1.03	5	1.80	6	24.91	88



TABLE II.

## ANNUAL RAINFALL AND NUMBER OF DAYS ON WHICH RAIN FELL.

Year.	Alicedale.		Salem.		Port Alfred.		Grahamstown.				Sydney's Hope Highlands.	
	Ins.	D.	Ins.	D.	Ins.	D.	Prison and Gaol.		Messrs. W. & C. Gowie.		Ins.	D.
1879....	—	—	23·24	83	—	—	30·16	—	—	—	—	—
1880....	—	—	27·58	78	34·03	100	36·41	—	—	—	—	—
1881....	20·90	54	24·26	93	35·33	92	33·08	—	—	—	—	—
1882....	15·99	38	20·94	84	26·40	83	28·78	—	—	—	—	—
1883....	12·93	40	17·92	64	19·64	74	23·85	—	—	—	—	—
1884....	10·50	54	19·50	79	25·59	106	28·87	—	—	—	—	—
1885....	17·49	75	23·65	85	25·80	87	32·17	—	—	—	—	—
1886....	28·49	76	34·13	77	35·97	88	42·52	—	—	—	—	—
1887....	17·34	60	20·13	68	28·24	82	28·28	—	—	—	—	—
1888....	22·45	85	29·42	82	29·74	101	35·36	—	—	—	—	—
1889....	18·77	72	28·37	79	32·30	104	30·69	—	—	—	—	—
1890....	9·54	52	17·76	69	17·11	117	23·83	—	—	—	—	—
1891....	21·20	61	32·65	86	31·76	130	40·25	—	30·03	88	—	—
1892....	19·66	61	20·03	69	23·05	115	28·09	—	21·49	37	—	—
1893....	18·79	64	24·91	84	33·52	126	36·58	—	24·96	48	25·70	133
1894....	16·66	39	18·93	65	23·66	105	30·77	—	22·14	42	21·82	98
1895....	14·61	36	20·75	64	24·93	120	28·81	—	19·31	42	19·20	99
1896....	13·43	35	22·29	58	28·00	103	24·90	—	20·99	52	20·88	106
1897....	15·45	35	22·62	74	38·64	92	27·49	—	15·87	35	20·90	93
1898....	13·69	28	17·50	75	20·51	92	24·12	—	17·14	40	22·46	105
1899....	10·04	33	14·77	69	15·97	93	19·40	—	14·39	51	16·97	111
1900....	5·99	25	16·69	65	21·57	91	24·26	—	19·14	48	15·31	91
1901....	10·48	21	19·13	74	19·89	106	26·26	—	19·25	52	22·78	105
1902....	13·04	20	20·60	48	—	—	29·21	—	22·82	49	23·58	98
1903....	8·37	24	19·90	58	—	—	28·21	—	22·81	54	21·38	86
1904....	10·49	22	14·10	40	—	—	21·90	—	22·71	42	20·33	101
1905....	—	—	19·26	32	26·57	82	26·06	—	29·45	58	21·97	113
1906....	20·82	29	28·33	66	37·39	85	37·83	—	41·48	84	33·32	132
1907....	9·76	15	14·12	41	20·21	71	22·26	—	21·48	58	20·04	126
1908....	13·50	26	21·01	32	34·45	48	29·46	—	28·89	68	23·42	111
1909....	13·54	39	Station closed	—	20·22	65	31·69	—	33·14	75	22·72	119
1910....	23·09	23	closed	—	31·40	73	31·94	—	35·32	66	27·78	132
1911....	16·56	25	„	—	27·80	62	31·90	—	36·75	64	27·95	107
1912....	13·88	45	„	—	—	—	21·54	—	29·36	69	22·86	115
1913....	17·97	60	„	—	24·16	76	32·28	93	31·34	68	24·53	114
1914....	18·42	51	„	—	21·29	71	27·76	105	29·08	75	24·70	118
1915....	10·78	41	„	—	21·07	72	24·53	101	26·84	71	20·39	114
1916....	14·95	55	„	—	17·16	63	19·84	71	23·30	69	21·48	103
1917....	18·40	57	„	—	33·81	89	32·13	103	40·77	95	28·35	123
1918....	17·26	39	„	—	24·88	74	23·17	101	28·17	79	24·33	116
1919....	9·25	21	„	—	21·44	57	19·84	76	25·06	58	14·69	88
1920....	—	—	„	—	16·62	62	19·34	85	20·39	69	17·84	100
1921....	19·80	75	„	—	27·71	72	31·76	112	36·48	88	24·04	125
1922....	18·31	39	„	—	42·69	63	39·30	84	35·93	76	27·34	100
1923....	11·51	42	„	—	25·89	71	24·48	98	20·15	67	17·30	114
1924....	14·38	47	„	—	18·77	74	21·63	98	17·41	73	19·34	112
1925....	15·88	67	„	—	24·38	93	31·90	110	22·84	94	25·03	124
1926....	13·16	39	„	—	23·21	73	25·21	78	20·29	58	19·78	105

TABLE II—(continued).

## ANNUAL RAINFALL AND NUMBER OF DAYS ON WHICH RAIN FELL—(con.)

Year.	Alicedale.		Salem.		Port Alfred.		Grahamstown.				Sydney's Hope Highlands.	
							Prison and Gaol.		Messrs. W. & C. Gowie.			
	Ins.	D.	Ins.	D.	Ins.	D.	Ins.	D.	Ins.	D.	Ins.	D.
1927....	6·60	28	Station closed.		14·66	47	15·79	65	11·42	52	12·30	93
1928....	17·83	55	,,		32·32	91	29·27	81	22·41	75	25·02	111
1929....	14·78	54	,,		30·41	83	27·35	95	21·12	82	22·70	118
1930....	16·42	45	,,		24·79	92	35·95	89	27·00	74	24·98	—
1931....	22·23	40	,,		34·16	89	29·80	79	24·65	59	27·38	—
1932....	16·45	35	,,		32·80	77	28·29	75	26·30	58	23·81	—
1933....	12·80	29	,,		25·22	67	22·29	81	20·42	61	20·01	—
1934....	19·66	33	,,		28·81	71	31·13	100	31·95	76	27·27	—
1935....	23·00	60	,,		36·05	75	34·18	116	31·54	89	32·04	115

TABLE III.

MONTHLY RAINFALL TOTALS AND NUMBER OF DAYS ON WHICH RAIN FELL.

41-42

Year.	Station.	Jan.		Feb.		March.		April.		May.		June.		July.		Aug.		Sept.		Oct.		Nov.		Dec.		Total.	
		Ins.	D.	Ins.	D.	Ins.	D.	Ins.	D.	Ins.	D.	Ins.	D.	Ins.	D.	Ins.	D.	Ins.	D.	Ins.	D.	Ins.	D.	Ins.	D.	Ins.	D.
1910.....	Rockcliffe (Sandflats).....	0.62	1	2.70	6	2.05	5	0.50	2	3.54	2	0.99	3	—	—	0.24	1	0.35	1	2.28	3	1.68	2	—	—	14.95	26
	Grahamstown (Gaal).....	1.09	—	6.50	—	2.73	—	3.48	—	8.55	—	0.77	—	0.34	—	0.11	—	1.41	—	4.28	—	1.77	—	3.91	—	31.94	—
	Brandeston (Fort Brown)....	1.53	4	4.86	9	3.23	4	0.25	2	5.98	2	0.64	2	0.25	1	0.25	1	0.16	1	2.23	4	0.98	4	1.35	1	21.71	35
1911.....	Rockcliffe.....	2.56	4	—	—	2.25	3	0.80	2	2.55	3	1.63	1	0.47	2	—	—	0.90	3	2.54	4	1.39	3	—	—	15.09	25
	Grahamstown.....	4.99	—	1.68	—	4.81	—	2.97	—	3.70	—	2.32	—	0.57	—	1.50	—	2.85	—	3.47	—	2.63	—	0.41	—	31.90	?
	Brandeston.....	2.04	2	2.73	3	3.28	5	1.24	2	0.85	2	0.89	1	—	—	0.66	2	1.62	1	1.62	5	1.54	6	—	—	16.47	29
1912.....	Rockcliffe.....	3.86	4	1.27	2	0.70	1	2.46	2	—	—	1.37	2	1.10	1	0.81	2	1.30	3	1.32	3	—	—	—	—	14.19	20
	Grahamstown.....	4.14	—	2.32	—	1.93	—	3.88	—	0.59	—	1.94	—	0.84	—	0.61	—	0.98	—	1.37	—	0.72	—	2.20	2	21.54	?
	Brandeston.....	1.14	5	1.63	4	0.86	4	2.35	2	—	—	1.75	2	0.54	1	0.25	1	0.66	2	0.65	2	0.32	1	0.92	5	11.07	29
1913.....	Rockcliffe.....	2.37	3	1.04	2	2.59	7	1.18	1	0.98	1	0.18	1	0.79	3	0.18	1	2.27	2	0.93	2	0.25	1	—	—	12.76	24
	Grahamstown.....	3.04	7	4.05	13	7.07	15	1.73	7	1.13	4	0.82	3	1.15	5	1.24	5	5.98	12	0.94	6	3.61	11	1.52	5	32.28	93
	Brandeston.....	3.66	6	2.98	7	1.66	4	0.69	2	0.38	2	0.80	2	0.40	3	0.58	4	4.51	9	1.05	2	1.11	4	0.16	1	17.98	46
1914.....	Rockcliffe.....	1.71	3	1.55	1	0.88	2	0.36	1	2.73	2	0.17	1	—	—	2.40	3	—	—	0.81	2	2.58	3	—	—	13.17	18
	Grahamstown.....	5.19	14	3.25	8	1.75	10	0.99	5	2.19	9	2.50	5	0.57	2	1.97	7	0.89	10	1.76	13	3.71	12	2.99	10	27.76	105
	Brandeston.....	1.65	3	1.54	3	1.24	4	—	—	3.35	3	0.86	3	—	—	1.14	3	0.10	2	0.91	3	1.00	1	1.25	1	13.04	26
1915.....	Rockcliffe.....	0.47	1	0.18	1	—	—	1.10	2	1.62	4	—	—	3.23	4	—	—	0.23	1	1.31	4	0.16	1	0.50	1	8.80	19
	Grahamstown.....	4.31	18	1.32	7	0.68	8	4.15	10	1.63	7	0.73	5	3.51	11	0.15	6	0.83	3	2.85	8	1.93	9	2.45	9	24.53	101
	Brandeston.....	?	?	?	?	?	?	0.12	1	?	?	?	?	1.17	3	0.16	1	0.16	1	0.63	5	0.70	5	3.12	5	?	?
1916.....	Rockcliffe.....	1.13	2	—	—	2.70	5	0.66	4	3.85	5	—	—	0.63	1	0.50	1	0.41	2	0.08	1	0.44	1	2.15	2	12.55	24
	Grahamstown.....	2.34	13	0.80	6	3.01	11	1.00	4	4.07	7	0.04	1	0.57	2	1.22	2	0.25	4	1.34	7	1.31	5	3.89	9	19.84	71
	Brandeston.....	0.82	5	0.21	1	3.62	9	0.52	4	2.67	5	—	—	0.25	1	0.64	1	0.12	2	0.89	4	0.29	1	1.54	3	11.57	36
1917.....	Rockcliffe.....	0.67	2	1.76	4	1.73	6	1.96	6	0.08	1	2.37	1	3.07	4	0.75	4	1.72	4	1.63	5	0.73	1	0.35	2	16.82	40
	Grahamstown.....	1.75	10	1.18	5	2.88	14	1.59	7	0.35	4	2.31	3	3.56	7	0.84	7	2.86	12	5.82	13	7.26	12	1.73	9	32.13	103
	Brandeston.....	0.74	4	0.99	4	3.01	9	2.09	4	0.23	1	2.20	3	1.99	4	0.34	1	2.01	5	2.03	2	4.51	3	0.96	4	21.10	44
1918.....	Rockcliffe.....	1.21	4	—	—	3.58	6	1.32	2	1.97	4	0.73	1	0.49	3	0.36	1	2.79	3	1.21	2	—	—	0.97	3	14.63	29
	Grahamstown.....	2.97	16	1.90	10	4.51	10	1.10	5	1.69	9	1.17	3	0.34	8	1.25	9	3.52	6	2.18	8	0.75	6	1.79	11	23.17	101
	Brandeston.....	1.85	3	0.25	1	3.77	6	1.17	6	0.99	8	0.36	3	0.32	4	0.52	3	3.10	7	1.66	8	0.19	1	1.26	6	15.44	56
1919.....	Rockcliffe.....	0.40	1	1.51	2	1.74	5	0.65	2	—	—	1.41	3	—	—	0.45	1	0.65	1	1.85	1	0.72	3	0.23	1	9.61	20
	Grahamstown.....	1.03	4	3.39	8	3.15	12	1.38	8	1.33	6	1.21	5	0.52	4	1.23	5	0.37	3	2.98	6	2.62	10	0.63	5	19.84	76
	Brandeston.....	0.08	1	2.25	6	1.62	8	1.02	6	1.76	4	0.27	2	0.20	2	—	—	0.07	1	0.59	4	0.73	5	0.30	2	8.89	41
1920.....	Rockcliffe.....	0.58	3	2.22	3	1.30	1	0.44	2	0.24	2	0.37	1	0.58	3	0.40	1	0.45	2	1.30	1	1.41	2	2.84	4	12.13	25
	Grahamstown.....	2.04	10	2.90	11	2.05	8	1.17	7	0.99	6	0.53	4	0.68	3	0.56	6	0.54	4	1.48	6	2.58	7	3.82	13	19.34	85
	Brandeston.....	1.31	6	3.62	9	1.15	4	0.70	4	0.11	2	0.33	2	0.23	3	0.02	2	0.29	2	0.64	3	1.39	3	1.84	3	11.63	43
1921.....	Rockcliffe.....	0.32	2	3.42	5	3.17	8	2.68	5	1.57	3	0.50	1	0.30	1	0.23	2	0.34	2	0.33	1	3.55	5	3.35	8	19.76	43
	Grahamstown.....	1.19	5	2.47	7	4.70	17	6.17	14	1.40	13	1.06	4	1.49	8	0.75	6	2.17	9	0.91	7	6.12	—	3.33	14	31.76	112
	Brandeston.....	0.50	2	1.23	4	4.27	8	4.14	5	0.35	1	0.19	1	0.32	2	0.27	3	—	—	—	—	4.17	5	3.39	6	18.83	37
1922.....	Rockcliffe.....	1.14	3	0.28	2	1.05	2	1.62	5	1.70	3	2.95	3	1.20	1	0.96	3	—	—	—	—	4.66	9	0.21	1	15.77	32
	Grahamstown.....	2.68	9	1.75	9	1.52	7	2.25	7	3.07	7	4.90	4	4.20	3	1.22	7	2.22	7	1.67	5	12.12	14	1.70	5	39.30	84
	Brandeston.....	1.19	5	0.35	1	0.20	1	0.89	2	1.06	1	2.81	1	2.20	3	0.08	1	—	—	0.25	1	5.56	7	0.45	1	15.13	24
1923.....	Rockcliffe.....	1.00	4	1.55	6	0.25	1	0.96	3	0.71	3	0.75	2	3.21	2	0.35	2	0.27	1	0.72	1	1.04	2	0.25	1	11.06	28
	Grahamstown.....	5.16	15	3.48	9	1.71	9	1.46	12	0.99																	



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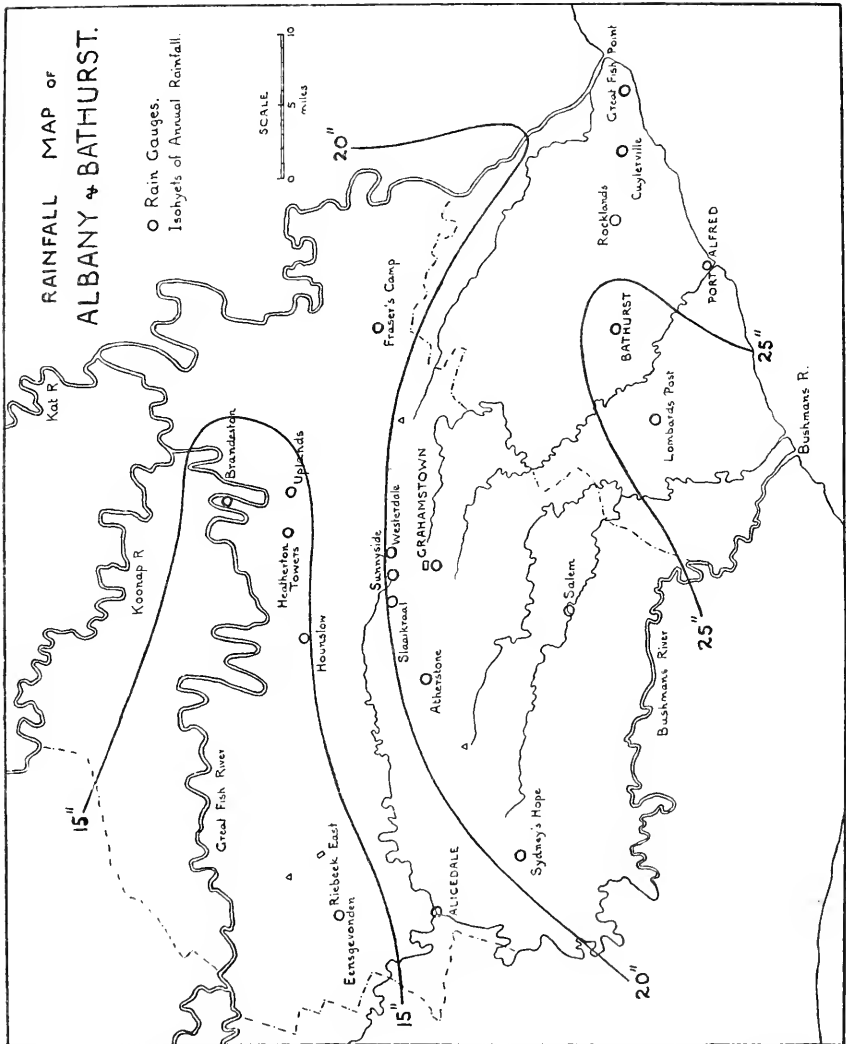
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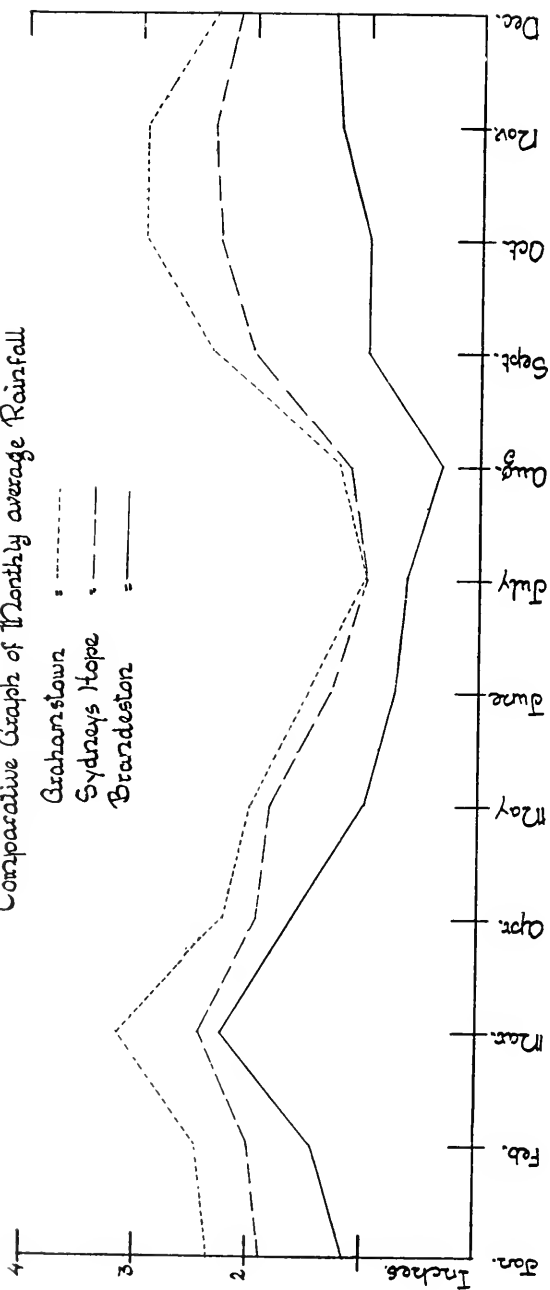
# RAINFALL MAP OF ALBANY & BATHURST.

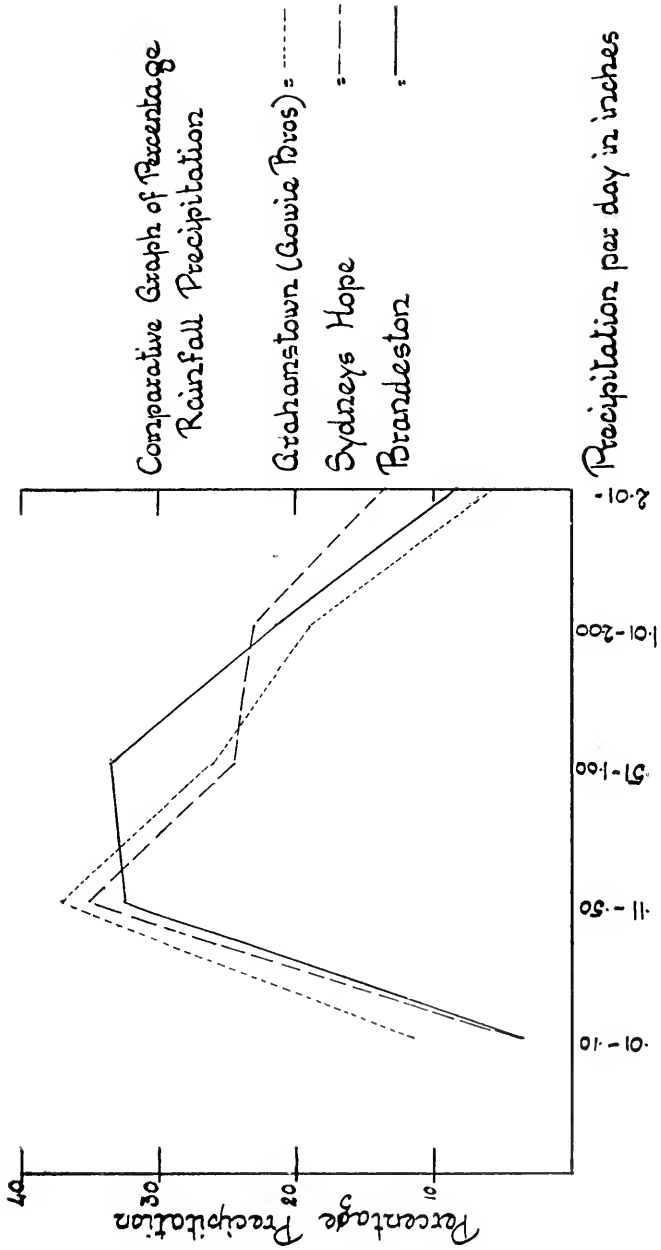
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Comparative Graph of Monthly average Rainfall





*Temperature.*

Official temperature data are scarce. Unfortunately no complete records are available from either the dry valleys of the Bushman's or Fish Rivers. It leaves a gap in the account of the conditions under which karroid scrub exists in these areas but occasional figures supplied by farmers make up this deficiency to a certain degree. Of the official figures available the mean maximum, mean minimum, absolute maximum and absolute minimum, recorded at Port Alfred and Grahamstown, have been selected as giving a fair impression of the prevailing conditions over most of the area. Port Alfred figures may be taken as representative of coastal conditions and Grahamstown figures of inland conditions, excluding the valleys mentioned.

As in other areas the temperature at the coast (Port Alfred) is more equable than inland (Grahamstown). The mean maximum temperature in summer is usually slightly higher in Grahamstown, whereas during winter months it is fairly consistently lower in Grahamstown. In the case of the mean minimum temperatures these are consistently lower in Grahamstown both in summer and winter. The figures for absolute maximum and absolute minimum temperatures accentuate these features.

The coastal belt is practically free from frosts and in the 7 years covered by the records  $35^{\circ}$  F. was the lowest temperature registered at Port Alfred. In the same period temperatures of  $32^{\circ}$  F. or lower were registered annually in Grahamstown with an absolute minimum of  $26.6^{\circ}$  F.

With regard to the influence of temperature on the Flora, it seems obvious that it is the absolute maximum and absolute minimum to which most importance should be attached. On these occasions temperature is exerting its greatest force as a limiting factor of plant growth.

Referring to Table V,  $103^{\circ}$  F. is the absolute maximum for Port Alfred as compared with  $108.2^{\circ}$  F. at Grahamstown, not, however, during the same year. The  $103^{\circ}$  F. at Port Alfred corresponded with  $107.4^{\circ}$  F. in Grahamstown and the  $108.2^{\circ}$  F. in Grahamstown corresponded with only  $92^{\circ}$  F. at Port Alfred.

Although the figures in Table VI are incomplete and were recorded by the farmer as a matter of personal interest, they serve to illustrate approximately the severe conditions experienced by plants in karroid scrub. The maximum temperature of  $112^{\circ}$  F. is not an isolated occurrence. According to unregistered figures higher temperatures are not infrequent in the Fish River valley.

The number of times frosts are recorded in the table is significant and the rise from  $53^{\circ}$  F. to  $102^{\circ}$  F. on March 12th, 1926, is noteworthy, a difference of  $49^{\circ}$  F., during the day.

TABLE IV.

## GRAHAMSTOWN (ABOUT 1,780 FEET).

(TEMPERATURE, FAHRENHEIT SCALE.)

Year.	January.		February.		March.		April.		May.		June.	
	Mean Max.	Mean Min.	Mean Max.	Mean Min.	Mean Max.	Mean Min.	Mean Max.	Mean Min.	Mean Max.	Mean Min.	Mean Max.	Mean Min.
1926.....	79.9	55.4	78.9	56.1	77.6	53.4	75.6	50.4	69.6	46.9	69.6	40.7
1927.....	80.6	56.3	81.9	58.3	77.7	56.5	79.5	50.9	70.3	42.6	69.1	38.6
1928.....	82.2	55.3	80.5	50.0	81.0	56.6	76.4	48.2	72.5	43.1	66.6	39.5
1929.....	81.5	55.3	81.7	54.2	76.0	54.9	78.1	48.5	70.4	46.3	65.1	42.7
1930.....	80.8	55.0	78.3	55.2	75.8	56.7	74.2	48.2	72.3	46.2	64.7	38.7
1931.....	81.7	58.4	81.4	59.0	83.1	58.9	72.3	47.8	70.4	44.2	66.1	38.0
1932.....	75.4	54.5	79.0	59.6	79.4	55.2	82.3	53.6	74.4	46.5	65.5	40.6
	Abs. Max.	Abs. Min.	Abs. Max.	Abs. Min.	Abs. Max.	Abs. Min.	Abs. Max.	Abs. Min.	Abs. Max.	Abs. Min.	Abs. Max.	Abs. Min.
1926.....	95.2	47.6	104.8	45.6	94.2	43.4	89.6	39.8	85.6	34.2	83.6	35.2
1927.....	104.2	43.4	107.4	48.5	104.2	50.5	94.2	41.0	91.5	32.5	77.8	30.0
1928.....	105.0	45.0	106.6	41.2	99.4	40.2	89.6	39.2	82.6	36.0	80.6	32.5
1929.....	96.0	42.8	101.8	40.2	94.0	48.0	92.4	38.2	88.6	36.6	80.6	34.2
1930.....	102.4	44.0	95.8	46.0	93.6	49.2	91.2	40.0	85.8	37.2	89.2	31.8
1931.....	100.4	41.8	100.8	50.0	102.4	51.0	89.2	38.4	86.2	29.0	79.6	27.2
1932.....	97.8	43.4	96.4	53.2	100.2	46.2	96.6	40.0	84.6	37.0	78.0	31.2

Figures taken from Meteorological Office Reports.

TABLE IV—(continued).

## GRAHAMSTOWN—(continued).

Year.	July.		August.		September.		October.		November.		December.	
	Mean Max.	Mean Min.	Mean Max.	Mean Min.	Mean Max.	Mean Min.	Mean Max.	Mean Min.	Mean Max.	Mean Min.	Mean Max.	Mean Min.
1926.....	64.0	38.5	68.9	43.1	69.5	43.7	75.3	47.8	71.5	50.5	78.7	54.6
1927.....	70.3	39.8	73.8	42.1	76.5	46.4	76.5	49.3	83.3	52.8	80.9	54.1
1928.....	68.6	40.0	69.9	40.4	69.5	42.7	71.5	46.5	77.5	48.6	78.9	54.3
1929.....	64.2	39.5	68.3	43.8	66.1	47.0	68.3	48.9	74.6	50.9	78.3	56.0
1930.....	64.2	39.3	67.4	40.9	66.5	42.4	71.4	51.0	78.1	49.7	80.2	56.3
1931.....	60.4	40.0	66.7	41.2	69.2	43.9	68.4	48.0	78.3	53.1	80.7	54.9
1932.....	65.4	37.8	71.0	42.2	68.7	47.2	70.3	48.4	74.5	53.6	74.4	52.3
	Abs. Max.	Abs. Min.	Abs. Max.	Abs. Min.	Abs. Max.	Abs. Min.	Abs. Max.	Abs. Min.	Abs. Max.	Abs. Min.	Abs. Max.	Abs. Min.
1926.....	74.4	26.6	89.4	33.6	92.6	33.0	102.8	34.6	93.6	42.5	101.2	41.5
1927.....	81.2	27.6	88.4	34.6	99.2	34.8	92.4	40.0	104.6	43.2	98.8	42.0
1928.....	81.2	31.0	85.4	28.4	89.8	32.2	86.0	39.2	93.6	40.6	93.6	46.0
1929.....	78.4	33.0	81.0	32.0	84.2	39.2	83.2	40.8	87.2	40.0	93.4	41.4
1930.....	75.4	29.8	80.4	34.0	82.4	34.5	99.6	36.2	96.2	42.0	106.0	40.0
1931.....	75.5	32.2	82.6	31.6	96.0	33.0	89.6	39.2	100.2	41.0	108.2	43.2
1932.....	77.2	29.8	86.8	31.6	93.6	39.0	90.6	33.0	99.2	42.0	92.8	42.5

Figures taken from Meteorological Office Reports.

TABLE V.

## PORT ALFRED (ABOUT 200 FEET).

(TEMPERATURE, FAHRENHEIT SCALE.)

Year.	January.		February.		March.		April.		May.		June.	
	Mean	Min.	Mean	Min.	Mean	Min.	Mean	Min.	Mean	Min.	Mean	Min.
	Abs.	Max.	Abs.	Max.	Abs.	Max.	Abs.	Max.	Abs.	Max.	Abs.	Max.
1926.....	78.3	65.5	78.5	64.6	76.1	61.4	74.4	57.6	71.8	52.2	69.7	47.7
1927.....	79.1	61.2	80.4	62.9	76.7	62.9	78.5	58.5	72.2	50.5	69.5	46.5
1928.....	79.1	63.9	78.9	58.7	77.7	57.0	76.8	—	71.9	52.0	69.9	46.3
1929.....	79.7	58.7	80.9	60.6	76.4	59.1	77.8	54.8	72.5	53.0	68.1	50.1
1930.....	79.5	61.3	77.8	60.1	78.2	61.1	76.2	54.6	75.0	52.4	68.5	46.5
1931.....	82.8	62.6	78.6	64.2	80.5	62.6	73.3	54.7	71.2	51.5	69.1	47.0
1932.....	77.5	58.9	80.4	64.2	79.1	60.7	80.2	59.9	77.3	54.2	69.4	48.5
	Abs.	Min.	Abs.	Max.	Abs.	Min.	Abs.	Max.	Abs.	Max.	Abs.	Min.
1926.....	83.5	59.5	87.0	60.0	86.0	51.5	88.0	49.0	93.0	42.5	89.0	42.0
1927.....	86.0	51.0	103.0	54.5	95.0	56.0	99.0	49.0	95.0	42.0	84.0	38.0
1928.....	87.0	53.0	90.0	44.0	93.0	45.0	96.0	—	87.0	45.0	85.0	39.0
1929.....	91.0	50.0	96.5	51.0	87.0	50.0	97.0	46.0	89.0	43.0	79.0	41.0
1930.....	93.0	53.0	85.0	53.0	94.0	54.0	98.0	48.0	89.0	44.0	81.0	39.0
1931.....	98.0	55.0	100.0	55.0	90.0	54.0	88.0	46.0	93.0	41.0	84.0	36.0
1932.....	85.0	50.0	87.0	59.0	91.0	54.0	91.0	48.0	94.0	46.0	79.0	38.0
	Abs.	Min.	Abs.	Max.	Abs.	Min.	Abs.	Max.	Abs.	Max.	Abs.	Min.

Figures taken from Meteorological Office Reports.



TABLE V—(continued).

## PORT ALFRED—(continued).

Year.	July.		August.		September.		October.		November.		December.	
	Mean Max.	Mean Min.	Mean Max.	Mean Min.	Mean Max.	Mean Min.	Mean Max.	Mean Min.	Mean Max.	Mean Min.	Mean Max.	Mean Min.
1926.....	66.9	45.8	67.4	49.6	69.0	51.6	71.8	56.6	—	—	77.3	61.0
1927.....	71.7	46.3	72.6	50.6	72.7	53.2	71.8	55.3	—	—	78.1	60.9
1928.....	71.1	48.8	69.4	47.8	67.2	50.9	68.6	53.8	73.4	56.6	76.5	59.5
1929.....	67.7	46.3	70.2	49.0	68.0	53.1	71.2	54.9	74.1	55.9	79.0	61.5
1930.....	68.3	47.1	69.9	48.4	68.3	49.4	72.1	55.7	76.4	55.5	81.5	62.4
1931.....	66.2	46.6	70.2	48.6	70.9	50.3	70.1	53.9	77.8	57.5	78.6	60.3
1932.....	71.1	46.3	73.2	49.0	68.7	52.9	71.7	54.4	77.3	58.5	76.2	58.6
	Abs. Max.	Abs. Min.	Abs. Max.	Abs. Min.	Abs. Max.	Abs. Min.	Abs. Max.	Abs. Min.	Abs. Max.	Abs. Min.	Abs. Max.	Abs. Min.
1926.....	82.0	40.0	84.0	40.0	99.0	41.5	96.0	44.0	—	—	97.0	50.0
1927.....	85.0	35.0	96.5	42.0	90.0	43.0	79.0	45.0	96.0	49.0	87.0	50.0
1928.....	88.0	40.0	87.0	38.0	80.0	43.0	81.0	44.0	81.0	48.0	81.0	53.0
1929.....	86.0	40.0	85.0	38.0	79.0	46.0	83.0	43.0	82.0	43.0	87.0	50.0
1930.....	78.0	39.0	86.0	42.0	82.0	40.0	107.0	42.0	97.0	45.0	99.0	47.0
1931.....	84.0	40.0	91.0	38.0	100.0	40.0	81.0	48.0	99.0	50.0	92.0	53.0
1932.....	86.0	36.0	92.0	40.0	79.0	45.0	81.0	45.0	100.0	50.0	82.0	51.0

Figures taken from Meteorological Office Reports.

TABLE VI.

(B. D. DOLD) (TEMPERATURE, FAHRENHEIT SCALE).

1925.		1926.	
Date.	Temperature.	Date.	Temperature.
	° F.		° F.
Jan. 1.....	112	Jan. 15.....	98
Feb. 4.....	104	„ 21.....	92
„ 7.....	v.h.	„ 24.....	94
„ 11.....	v.h.	Feb. 6.....	102
„ 22.....	112	„ 14.....	104
„ 27.....	v.h. wind	„ 20.....	100
Mar. 20.....	v.h., 102	„ 24.....	106
Apr. 14.....	54	Mar. 7.....	103
June 26.....	h.f.	„ 12.....	53-102
July 2.....	f.	„ 22.....	100
„ 7.....	h.f., 41	„ 17.....	96
„ 9.....	f.	May 26.....	first frost
„ 10.....	f.	July 22.....	h.f.
„ 26.....	f., 44	„ 25.....	v.h.f.
Aug. 9.....	v.h.	Sept. 16.....	f.
„ 10.....	v.h.	„ 17.....	f.
„ 14.....	h.f.	Oct. 11.....	94
„ 20.....	f.	„ 12.....	108½
„ 24.....	h.f.	„ 13.....	cool day
Sept. 18.....	96	„ 17.....	110
Nov. 9.....	103	Nov. 2.....	cold day
„ 14.....	100	„ 10.....	90
„ 18.....	v.h.	„ 16.....	98
Dec. 16.....	101	„ 21.....	90
„ 23.....	101	Dec. 14.....	104
„ 25.....	104	„ 15.....	100
„ 30.....	100	„ 13.....	108

s.f. = slight frost.

h.f. = heavy frost.

h. = hot.

v.h. = very hot.

TABLE VII.

## RELATIVE HUMIDITY.

(Record kept at G.V.O. Office, Grahamstown.)  
RECORD OF HIGH RAINFALL, YEAR 1922 (35-09 Ins.).

Day.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1.....	78	55	67	65	93	100	46	57	—	57	86	57
2.....	83	65	72	75	85	75	42	48	63	70	82	45
3.....	38	82	88	73	67	62	96	68	48	67	68	56
4.....	73	80	100	61	58	66	53	42	53	85	90	86
5.....	83	61	78	36	47	57	83	52	95	61	96	66
6.....	82	50	78	42	42	71	93	100	92	70	93	60
7.....	74	88	77	100	87	93	61	96	68	64	96	81
8.....	93	88	88	88	75	47	86	94	52	52	90	73
9.....	93	94	70	85	43	—	93	59	67	65	55	88
10.....	93	87	94	87	35	—	50	45	82	72	86	68
11.....	88	72	78	83	82	—	84	57	78	52	93	60
12.....	100	45	67	57	90	90	99	69	44	49	99	54
13.....	88	93	83	72	60	79	43	56	76	59	64	55
14.....	79	88	74	84	71	100	99	56	70	90	61	69
15.....	77	84	100	97	100	96	44	68	72	66	69	86
16.....	83	71	88	74	97	77	78	64	75	59	75	79
17.....	53	68	88	75	82	54	48	74	90	66	60	68
18.....	71	88	100	73	61	97	90	84	63	40	65	78
19.....	88	82	88	67	67	95	93	59	59	48	61	97
20.....	84	82	84	56	83	57	94	48	70	64	85	67
21.....	76	88	76	75	100	93	92	59	83	73	90	60
22.....	52	88	87	74	93	74	77	49	75	94	78	73
23.....	63	88	76	77	63	100	67	71	99	65	80	66
24.....	73	84	79	76	39	—	91	88	57	54	90	77
25.....	74	94	64	90	100	73	99	88	66	54	80	46
26.....	83	84	73	79	77	83	84	77	93	40	61	60
27.....	70	88	73	89	86	96	99	81	64	30	64	63
28.....	69	74	73	82	100	56	66	91	59	33	66	49
29.....	94	—	60	87	69	67	68	79	70	41	53	63
30.....	100	—	60	88	98	93	36	79	50	81	61	70
31.....	76	—	100	—	97	—	72	94	—	95	—	75

TABLE VIII.

## RELATIVE HUMIDITY.

(Record kept at G.V.O. Office, Grahamstown.)  
RECORD OF LOW RAINFALL YEAR, 1927 (11·27 Ins.).

Day.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1.....	61	91	56	86	38	60	79	56	66	100	79	87
2.....	51	89	52	98	69	100	94	68	74	46	61	65
3.....	78	56	47	58	50	100	—	59	100	53	52	68
4.....	64	72	73	47	76	100	58	82	58	58	52	86
5.....	60	53	85	46	74	100	100	100	72	50	100	73
6.....	100	61	35	38	87	100	70	78	43	58	100	59
7.....	72	68	75	84	99	76	56	62	85	54	72	61
8.....	57	57	100	83	53	72	44	67	70	46	39	84
9.....	47	60	73	100	63	50	88	54	38	54	37	47
10.....	37	37	52	85	48	49	—	79	100	100	55	50
11.....	85	49	100	41	100	100	95	100	100	100	46	99
12.....	51	81	67	48	74	52	52	45	100	91	67	77
13.....	70	84	63	69	100	51	43	68	87	61	60	60
14.....	88	72	100	72	67	64	80	72	88	86	52	52
15.....	87	53	98	77	98	65	60	100	65	100	59	100
16.....	61	63	100	78	76	63	57	98	74	81	75	52
17.....	88	86	94	70	100	100	—	44	83	84	97	54
18.....	60	89	100	66	100	52	100	44	85	86	100	62
19.....	46	77	100	83	96	60	49	76	72	68	72	72
20.....	75	64	54	92	77	100	51	92	71	62	53	78
21.....	65	89	87	63	100	100	38	55	100	58	60	85
22.....	85	60	85	48	69	52	59	51	46	59	47	61
23.....	100	39	78	85	48	100	42	31	88	57	86	57
24.....	57	95	76	85	71	100	—	54	62	91	84	53
25.....	85	88	95	79	100	84	97	52	67	90	67	65
26.....	99	70	82	88	66	57	73	83	62	77	—	57
27.....	84	73	79	74	100	56	67	96	55	59	63	68
28.....	77	65	100	73	59	56	93	62	45	59	74	81
29.....	96	—	98	82	54	32	100	67	44	75	89	66
30.....	62	—	85	79	60	92	100	76	66	58	59	54
31.....	62	—	70	—	64	—	47	73	—	63	—	100

### *Humidity.*

Humidity records have been made at the Veterinary Office, Grahamstown, at Port Alfred and elsewhere, but as these, in common with most other official records, are calculated as at 8.30 a.m., they do not give a complete picture of the conditions, which may vary considerably during the course of a day. Figures calculated on readings taken at noon would be more important in interpreting the degree to which humidity functions as a limiting factor in plant growth. Lowest humidity records are obtained during "Berg" winds and humidity of 7 per cent. was registered at 8.30 a.m. during such a wind in November, 1920.

Tables VII and VIII give figures for the Relative Humidity in Grahamstown for a year of high and low rainfall, 1922 and 1927 respectively.

### *Winds.*

Records kept at the Veterinary Office, Grahamstown, show that the prevailing winds are S.E. and S.W., with W. winds fairly frequent in July and August. As in the case of *Humidity* readings, those for wind are also taken at 8.30 a.m., usually the calmest time of the day, and cannot, therefore, be taken as giving a complete picture. Records for other stations in this area are scanty. The S.E. winds are more frequent and much more forceful on the coast than they are further inland, and Grahamstown is further protected by surrounding hills. The shape of the scrub along the coast is considerably influenced and moulded by the high velocity of these S.E. winds. The velocity at inland stations naturally varies greatly according to the degree of protection. These winds are important for the reason that they frequently carry with them water vapour, either to be precipitated as rain or in the form of beneficial mists.

The "Berg" winds, referred to in detail by Bews (1912), Phillips (1931) and others, which blow mainly from the N.W., occur periodically throughout the year. Early summer is the most likely period. They are here less frequent and of shorter duration than in Natal. About 8 per year is a fair average and a change to cooler conditions often takes place before nightfall, and a reversal in the direction of the wind frequently gives rise to steady rains. These "Berg" winds often result in days of maximum temperatures and minimum humidity. As stated, humidity of 7 per cent. was registered at 8.30 a.m. during one of them in November, 1920.

### *Light.*

Sunshine observations have been carried out at the local Veterinary Office for a number of years and from these records Mr. C. D. B. Liebenberg calculated that the ratio of the possible hours of sunlight to the actual hours of sunlight is 100 : 60.5.

## SOME BIOTIC FACTORS.

### *Man, Direct and Indirect Influence.\**

#### *Fire and Veld Management.*

The firing of vegetation has taken place from very early times by various means, but systematic burning is a practice introduced to this area by civilised man. It has been used, not only to prevent the spread of bush, but also to push back the succession to the advantage of grassveld. Veld burning, together with heavy stocking, has very materially altered the vegetation in many parts.

\* Soil erosion, which is extensive in parts, is the subject of a special investigation at Rhodes University College.

In some cases it has resulted in the increase and gradual dominance of "rhenoster," *Elytropappus Rhinocerotis* Less. This is particularly noticeable along the railway line from Grahamstown to Alicedale. Along the same route, *Sclago corymbosa* Linn., and *Bobartia* sp. are abundant in parts. Overstocking with sheep, without burning, has brought about the spread of these plants in other localities also. *Watsonia Meriana* Miller was at one time very abundant on the Zwartwaterbergen (continuation of Zuurberg) but is now almost restricted to the protected area along the railway line.

*Acacia Karroo* Hayne, due to changes in veld management, is becoming a pest in certain grassveld areas (Dyer, 1930).

### *Introduction of Exotics.*

During the past fifty odd years introduced *Pinus pinaster* and one or two other species have gradually encroached on the indigenous vegetation in the vicinity of Grahamstown, particularly on the Mountain Drive. These and species of *Eucalyptus* have been the direct cause of the complete drying up or at least the intermittent flow of small perennial springs in this area. Partly in consequence of their demands on the water supply, and no doubt also due to some extent to chemical changes in the soil, there is practically no undergrowth or germination of bush species in *Pinus* and *Eucalyptus* thickets. The timber is not worth carting away and the spread of these exotics is a definite menace to indigenous vegetation.

At one time *Hakea acicularis* showed signs of becoming even a greater menace than the pine trees and steps were taken by the Divisional Councils of Albany and Bathurst to hold it in check.

Introduced *Opuntia* spp. (prickly pears) have spread extensively in karroid veld, not so much due to faults in veld management, as to their adaptability to the particular climatic conditions. *Opuntia aurantiaca* Lindl. (jointed cactus), although not so extensive in its distribution in this area as in neighbouring divisions, is nevertheless a serious menace owing to the rapidity with which it is capable of spreading in karroid veld. It is largely due to the perseverance of Dr. S. Schonland that serious efforts are being made by the Union Government to control the pest.

### *Animals, Birds, etc.*

Formerly this area abounded in large wild game which to-day is extremely scarce by comparison. An important point with regard to wild animals and the balance of biotic factors is the selective feeding of game, each species showing a preference for certain plants. By this means they are able to live together without acute competition.

Ostriches, which were farmed on a large scale in karroid veld a few years back, have been the means of reducing the frequency of many small succulents. These birds are particularly fond of stapeliads and species of *Mesembryanthemum*.

Small animals such as hares, meercats, rats, bats, tortoises, etc., and birds, all have an important bearing on various communities and the distribution of plant species. Other biotic factors are worms, termites, grasshoppers, locusts, etc., and to investigate thoroughly the inter-relationship of these with the flora requires a team of workers. Further references to veld changes will be found in the accounts of the various formations and communities.



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## Chapter 4.

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LAGOON VEGETATION.

VLEI, MARSH AND STREAM VEGETATION.

STRAND VEGETATION.

COASTAL LITHOSERE.

PSAMMOPHILOUS MACCHIA AND LITTORAL SCRUB.

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## CHAPTER 4.

## THE LAGOON VEGETATION (Initial Stage of Halosere).

The main rivers running into the sea on the Bathurst coast are the Great Fish River, which forms the northern boundary, the Bushman's River, which is the southern boundary, and between these, from the north, the Kleinemonde, Kowie, Kasonga and Kariëga Rivers. The Great Fish River is by far the longest, having its source in the Great Karroo in the Middelburg district. Before the subsidence of the coastline it had scoured out a very much deeper and broader valley than the other rivers mentioned. Consequently the "drowned" valley near the coast now contains far more extensive mud flats than found elsewhere along the coast. The Bushman's River, on the other hand, which is the second largest, has relatively small mud banks or islands, most of which are completely submerged at high tide. The Kowie River mouth has been altered considerably by artificial means for the convenience of shipping but quite extensive saline mud flats persist. There is no sharp line of distinction between the halosere, hydrosere and psammosere, some plants being tolerant of either saline or fresh water conditions. Low-lying strips of sand partly within the dunes may be submerged during spring tides and yet when a hole is dug a foot or two below the surface, fresh water may seep in. Thus for the most part the plant roots have a fresh water supply while the stems are constantly in a salty atmosphere.

The main stages in the plant succession may be traced as follows: *Zostera capensis* Setchell\* establishes itself in deeper water than any other flowering plant in this area. The ribbon-like leaves grow from the mud banks two feet or more below the surface, retaining silt gradually and raising the soil level to a height suitable for other pioneers. One of the most important species on the mud banks, regularly submerged at high tide, and in some places almost continuously so, is the grass *Spartina stricta* Roth. This has a strong deep rhizomatous root system, which effectively binds the soil and prepares the way for a mixed community such as *Suaeda maritima* Dum., *Chenolea diffusa* Thunb., *Salicornia* spp., *Limonium scabrum* O.K. (*Statice*), and *Triglochin bulbosum* Linn. The advent of these results in the more rapid formation and greater stability of the mudbanks which may later develop into more or less permanent islands. This type of succession is illustrated in Fig. 1.

At tide level on the river banks the flora becomes richer but *Chenolea diffusa*, *Suaeda maritima*, *Salicornia* spp. and *Limonium scabrum* are the commonest plants, any one species of which may form a dense consociation or together frequently form closed associations. They are followed by a rich cyperaceous flora, the commoner species being, *Cyperus textilis* Thunb., *C. sphaerospermus* Schrad., *C. usitatus* Burch., *Juncellus lacvigatus* C.B.Cl., also found inland, *Mariscus riparius* Schrad., *M. congestus* Vahl, also as a pioneer on sand dunes, *M. tabularis* C.B.Cl. and *M. durus* C.B.Cl., both also inland, *Eleocharis limosa* Schult., also inland, *Scirpus setaceus* Linn., *S. maritimus* Linn., *S. venustus* Boeck., *S. nodosus* Rottb., a robust species found also in sand dunes and along streams inland, often associated with *S. paludicola* Kunth, *S. Burkei* C.B.Cl.

\* (= *Zostera marina* of Fl. Cap. Vol. 7, p. 50.)

and *S. cernuus* Vahl. *Fuirena hirta* Vahl is another species adapted to either saline or fresh water conditions and on the mud flats near the Fish River mouth is dominant over a large expanse.

Associated with this cyperaceous flora, in addition to the outliers of the pioneer species mentioned previously, may be found *Plantago comosa* Lam., *Samolus porosus* Thunb., *S. Valerandi* Linn. *Chironia serpyllifolia* Lehm. var. *laxa* Grieseb. and *Aster ficoideus* Harv. *Juncus acutus* Linn. var. *Leopoldii* Burch. is common and dominant in parts.

*Sporobobus pungens* Kunth, due to its deep rhizomatous root system, is an excellent sand binder and, whereas it is usually above tide level, it also colonises periodically inundated mud flats. *Stenotaphrum secundatum* O.K. often becomes dominant along a narrow belt just out of reach of high tide where it forms a uniform matted sward. It also favours inland stream banks in well grazed areas such as Howiesons Poort. The intermediate zone between the saline mud flats and sand dunes is occupied also by other plants such as *Ficinia repens* Kunth, *Delosperma* sp. and *Spergularia marginata* Kitt.

Salt vleis and saline marshes near the coast, without direct communication with the sea, are, like the river mud banks, characterised by a rich cyperaceous flora, most of the species mentioned above being present. When the salinity decreases somewhat, notable additions to the flora are *Typha capensis* Rohrb., and *Phragmites communis* Trin. These are found both in slightly saline and in fresh water pools, usually being dominant or co-dominant forming consocieties and associations.

#### VLEI, MARSH AND STREAM VEGETATION.

(Part of the Hydrosere of Bews, 1920, p. 395, and Phillips, 1931, p. 107.)

As pointed out previously, the area in question, being as it is, situated between the areas dealt with by Bews and Phillips, shows a very close similarity in most of the important stages in succession along the coast. To detail all the facts in common would seem needless repetition.

The stage of submerged or partially submerged aquatics or hydrophytes is represented by *Potamogeton badius* Hagstr., *P. Thunbergii* Cham. & Schlecht., *Crassula natans* Thunb., and *C. inanis* Thunb., but the area occupied is relatively small.

*Floating aquatics*.—Species in this stage are also few, the most important being *Nymphaea capensis* Thunb. (*N. stellata* Harv.) whose large floating leaves may cover almost completely the surface of pools, and whose flowers make a grand sight in summer: usually associated with this is *Aponogeton Kraussianum* Hochst., and more rarely *A. spathaceum* Hook. f. var. *juncum* Hook. f., *Limnanthemum Thunbergianum* Grieseb., with its small yellow flowers, is found only in limited areas of streams, whereas *Lemna gibba* Linn. and *L. minor* Linn. have occasionally become pests on farm dams.

Floating aquatics may or may not be present when the *Typha* and *Phragmites* communities are met with. *Phragmites communis* Trin. is more restricted in its distribution locally than *Typha capensis* Rohrb. It is restricted mainly to waters near the coast, whereas *Typha capensis* penetrates occasionally to small vleis in Howiesons Poort, etc. It grows most luxuriantly (up to 8 ft. in height) when established in permanent water, but may also become firmly established on dry banks of either streams or vleis. *Cyperus textilis* Thunb. may be found in shallow water or in permanently muddy areas in association

with *Typha capensis* or with *Cyperus sexangularis* Nees. There is a gradual transition from the *Typha-Phragmites* stage to the stage of semi-aquatics. It may be well to emphasise Bews' statement (1920, p. 396) "it is easy to follow the succession in any particular vleis yet it is more difficult to generalise with regard to the coast hydrosere as a whole."

*Semi-aquatics*.—Cyperaceae predominate in most areas suited to the growth of semi-aquatics and the number of species is relatively high. The following are the more important, given roughly in order of their systematic classification: *Kyllinga erecta* Schumacher, *K. melanosperma* Nees, *Pycreus polystachyus* Beauv., and *P. lanceus* Turrill, the last two occasional in temporary vleis; *Juncellus laevigatus* C.B.Cl., frequent in both fresh or slightly saline vleis; *Cyperus tenellus* Linn., small annual; *C. difformis* Linn., *C. pulcher* Thunb., *C. denudatus* Linn., *C. albostratus* Schrad., *C. fastigiatus* Rottb., *Mariscus congestus* Vahl, *M. tabularis* C.B.Cl., *M. durus* C.B.Cl., *Eleocharis limosa* Schult., *Fimbristylis complanata* Link, *Scirpus globiceps* C.B.Cl., *S. costatus* Boeck., a species showing extraordinary variation in size, ranging from 8 ins. to 7 ft. in length, the latter length being attained by plants supported by stream bank bush; *S. cernuus* Vahl and *S. rivularis* Boeck. two common small annuals; *S. nodosus* Rottb. tolerant of wet or periodically dry conditions, *S. prolifer* Rottb., *S. Burkei* C.B.Cl., *S. paludicola* Kunth, *Fuirena hirta* Vahl, *Rhynchospora glauca* Vahl, *Carpha glomerata* Nees, *C. capitellata* Boeck., and *Tetraria cuspidata* C.B.Cl.

There is no fundamental difference between this list and the species mentioned by Bews l.c. 398. The genera and species are comparable, and from this it might be assumed that similar associations would exist in similar habitats elsewhere along the coast belt. On comparing the list with Phillips' account l.c. 110, the fallacy of any such assumption is apparent. Phillips lists no less than 19 species of *Ficinia*, 8 of which are also present in this area, yet with the possible exception of *F. bulbosa* Nees, these are found either in short open grassveld, on krantzies, or under the protection of bush, but not in muddy conditions. An explanation of this important difference is desirable.

Other Monocotyledons associated in the semi-aquatic stage are *Juncus capensis* Thunb., in a variety of forms, *J. effusus* Linn., *J. oxycarpus* E. Mey., *J. Dregeanus* Kunth, *J. indescritus* Steud., *J. lomaphyllus* Sprengl. *Zantedeschia aethiopica* Spreng. forms small associates but is rarely dominant or sub-dominant as in some other areas of the Cape and in Natal. Amongst the grasses we find *Danthonia cincta* Nees, *Polypogon monspeliensis* Desf., now more or less cosmopolitan, and to a certain extent, *Stenotaphrum secundatum* O.K.

Liliaceae have *Kniphofia uvaria* Hook., *Ornithogalum Zeyheri* Baker and *O. coarctatum* Jacq., two small species with white flowers, and the large white-flowered *O. lacteum* Jacq. (or closely allied species). Amaryllidaceae: *Cyrtanthus flavus* Barnes, the smallest species of the genus, is rare. *Crinum campanulatum* Herb., one of the most beautiful species in the genus, is found abundantly in inland depressions, which, during the rainy season become vleis. At this period the plants flower, and later when the vleis usually dry up and the soil bakes hard, the leaves die down and the bulb enters a resting period until the following summer.

Iridaceae include *Diets bicolor* Sweet and *Dierama pansum* N.E. Br., both comparatively rare in Blaauwkrantz Gorge and Trappes Valley respectively. Orchidaceae are occasional or locally common, including *Disa chrysostachys* Sweet, *Satyrium* spp. and *Habenaria* spp.

*Prionium Palmita* E. Mey., generally known as "palmiet," an endemic monotype of Juncaceae with a robust fibrous stem, is an important plant in certain areas and gives its name to a stream flowing through Howiesons Poort. It flourishes in the beds of running streams, withstands fire remarkably well, and gradually forms a dense growth, at which stage the matted roots effectually check soil erosion, Fig. 12. The palm *Phoenix reclinata* Jacq. occurs occasionally on stream banks a few miles inland, Figs. 10 and 11.

Dicotyledons are represented by: *Ranunculus pubescens* Thunb., *Rorippa fluvialis* R.A. Dyer, mostly in temporary pools in dry areas, *R. nasturtium-aquaticum* Hayek. (introduced "watercress"), *Cardamine africana* Linn., *Phacocarpus cracca* Bernh., *Pelargonium grossularioides* Ait., *P. parvirostre* R. A. Dyer, *Melanthus major* Linn., very robust but a rather rare herb, *M. Dregeana* Sond. somewhat woody and extending from stream banks into grassveld, *Psoralea glabra* E. Mey., *P. oligophylla* E. & Z., and two or three others. All of these may be found at some distance from water, providing the conditions are temperate. Temperate conditions are favoured also by some species of *Indigofera* and *Tephrosia polystachya* E. Mey. The same may be said of *Alchemilla capensis* Thunb., *A. elongata* E. & Z., *Geum capense* Thunb., and *Cliffortia graminea* L.f., all of which are somewhat rare. Others are *Drosera cuneifolia* Thunb., *Lythrum hyssopifolia* Linn., *Gunnera perpensa* Linn., *Laurembergia repens* Berg. Umbelliferae have such species as *Hydrocotyle verticillata* Thunb., *H. asiatica* Linn., *H. eriantha* var. *glabrata* Sond., which spread in muddy places by means of runners, *Sium Thunbergii* DC., *Valeriana capensis* Thunb.

Compositae are comparatively poorly represented, although if species favouring moist temperate places are included the list is somewhat longer: *Corymbium nereosum* Thunb., *Conyza ivifolia* Less., *Ursinia chrysanthemoides* Harv., *Matricaria nigellifolia* DC., *Artemisia afra* Jacq., *Cotula coronopifolia* Linn., *Cenia turbinata* Per., *Helichrysum capitellatum* Less., *Senecio rigidus* Linn. In Campanulaceae there are *Parastranthus thermalis* Sond., *Grammatotheca erinoides* Sond., and a few species of both *Wahlenbergia* and *Lobelia*. A number of Scrophulariaceae may be placed in this group but, here again, some are not restricted to mud or free water surfaces. Those that are, however, include *Ilysanthes dubia* Bernh., *Veronica anagallis* Linn., *Limosella aquatica* Linn. and *L. capensis* Thunb., two small plants producing runners on mud. In Lentibulariaceae we have *Utricularia capensis* Spreng. and *U. stellaris* L.f. A number of the herbaceous Labiatae are more or less mesophytic in habit.

#### THE STRAND VEGETATION (Initial Stage of the Psammosere).

The flora of the shifting coastal sand dunes is comparatively poor and the more important species in the plant succession are those of wide distribution along the coasts of tropical and sub-tropical countries. They are: *Scaevola Plumieri* Vahl (= *S. Lobelia* Murr. and *S. Thunbergii* E. & Z., Goodeniaceae); *Ipomoea Pes-caprae* Roth (Convolvulaceae); *Hydrophylax carnosa* Sond. (Rubiaceae); *Ehrharta gigantea* Thunb. (Gramineae). To these must be added *Sporobolus pungens* Kunth, an extremely tough stoloniferous grass, which plays an important part in colonisation between the sand dunes near river estuaries. It may form a pure community or an association with such plants as *Microstephium populifolium* Druce (= *M. niveum* Less.), *Passerina rigida* Wikstrom, *Helichrysum velleum* R. A. Dyer, *Gazania uniflora* Sims, and *Juncus acutus* Linn. var., or even *Salicornia* spp. in places reached by high tides.

The shifting dunes in this area are wide and extensive and even the first four plants mentioned above exert a far less beneficial effect as pioneers for sand fixation than they do in the more tropical climate of Natal. *Scaevola Plumieri* may be recognised at a distance by the characteristic sand-humps which it retains. On these humps it may form a pure stand or an association with *Ipomoea Pes-caprae* whose surface runners are in marked contrast to the deeply rooted stems of the former. *Hydrophylax carnosus*, a small succulent runner, is not found as extensively here as in more tropical parts.

*Ehrharta gigantea* is remarkable for the depth of sand through which it penetrates and eventually stabilises sufficiently to allow of further colonisation (Fig. 6). The secondary stage in this succession is sometimes made up by *Cnidium suffruticosum* Cham. & Schl., *Anthospermum littoreum* L. Bolus, *Zaluzianskya maritima* Walp., *Microstephium populifolium*, *Gazania uniflora*, *Passerina rigida* and *Psoralea* sp.

Other plants of varying importance among the Dicotyledons are: *Osteospermum moniliferum* Linn., one of the most plastic and adaptable shrubs in the South African flora, unique in the genus for its succulent fruits dispersed by birds; *Senecio* spp. *Dimorphotheca fruticosa* Less., *Euryops virgineus* Less., *Aster* spp., *Metalsia* sp., *Helichrysum teretifolium* Less., *H. praecinctum* Klatt, *Carpobrotus edulis* N.E. Br. (*Mesembryanthemum*) and one or two other species formerly classified under *Mesembryanthemum*. Ficoideae are also represented by *Tetragona decumbens* Mill., *Pharnaceum* sp. and *Aizoon rigidum* L.f. var. *angustifolia* Sond. a decumbent perennial. *Erica chloroloma* Lindl. is a rare shrub on more stable sand-veld; *Myrica cordifolia* Linn., the wax-berry, *Hebenstreitia cordata* Linn., *Manulea bellidifolia* Benth., *M. obovata* Benth., and *Sutera maritima* Hiern. are also present. *Salvia aurea* Linn., a small shrub, often takes a prominent part in early colonisation and may be associated with *Psoralea algoensis* E. & Z., and *Passerina vulgaris* Thoday. *Rhus crenata* Thunb. is frequent and takes an important part in sand dune fixation. *R. Schlechteri* Diels is found, but more usually in the denser macchia. This also applies to *Gymnosporia procumbens* Loesen., whereas *Cassine maritimum* L.B., another member of the Celastraceae, is often associated with *Rhus crenata* Thunb. as a pioneer.

Monocotyledons, other than the grasses mentioned, are not of primary successional importance. They are: *Restio Eleocharis* Mast., *Acidanthera pauciflora* Baker, *Albuea eircinata* Baker, *Anthericum falcatum* L.f., *Lissochilus speciosus* R. Br., *Pentaschistis heptamera* Stapf. *Danthonia gigantea*, an exotic, has become firmly established on the Kowie sands: *Ficinia aphylla* Nees and *F. repens* Kunth are also frequently abundant. *Ficinia aphylla* is another plant which shows, to a very marked degree, the effect of different exposure and "soil" conditions. It is difficult to realise from herbarium material that the various forms are the result of slight differences in environment. Pioneer plants, in exposed positions with only a few grains of sand for the root system to penetrate, are small and tangled into a stunted mass, whereas plants receiving the shelter of shrubs in deep sand develop erect culms and leaves to three or four times the height of the former.

Although the number of species in the strand vegetation is small, they belong to a wide range of families. Another point of interest is the prevalence of semi-succulence caused, directly in many examples, by the effect of the salt-laden coastal atmosphere and sand.

There is usually no sharp line of distinction between the typical psammose flora and the more stable psammophilous macchia, although stretches

of the coast may be devoid, or nearly so, of the recognised primary colonisers of the psammosere. The macchia and transitional flora will be referred to again after a brief consideration of the extreme aspect of coastal lithosere.

### THE LITHOSERE (in part, coastal).

The coast in the area under consideration lacks extensive rocky cliffs overlooking the sea and is comparatively rarely interrupted in this way. The north bank at the river mouths is usually rocky whereas the south bank is sandy, due to the fact that the rivers have gradually worn away the outlet to the sea in a northerly direction. The following remarks are more particularly applicable to the rocks on the north of Bushmans River mouth and Figs. 8 and 9 illustrate plant succession in this habitat. The rock consists of solidified raised beach sand which weathers somewhat readily but very irregularly, leaving small pockets and sharp angles all over the surface. On some of these rocks continually exposed to sea spray and without any soil whatever, a number of pioneer plants succeed in establishing themselves. On these rocks there is no question of a pioneer preparing the way for secondary colonisation—the conditions are too exacting—the pioneer is at the same time the climax type of vegetation. The plants are *Gazania uniflora*, *Limonium scabrum*, *Delosperma* sp. nov. (fide L. Bolus), and *Salicornia* sp. The *Delosperma* (Mesembryanthemum), is a small runner which forms a dense mat clinging to the rocky surface and this, like *Salicornia* sp., was not found in the sand dune flora.

As one goes shorewards into positions where a small accumulation of sand is possible, most species mentioned as typical of the psammosere occur here also. Those penetrating furthest towards the extreme conditions are *Osteospermum moniliferum*, *Ficinia aphylla*, *Passerina rigida*, *Cnidium suffruticosum*, *Phyllia* sp., *Helichrysum* sp. and *Senecio* spp. *Osteospermum moniliferum* is found with its stem closely pressed to the rocks in the nature of some *Ficus* species, the leaves are thick, fleshy and nearly glabrous; in coastal scrub it is an erect shrub, whereas when found as a coloniser in Namaqualand, and such-like arid places, the leaves are much reduced in size, tough, and densely covered with a woolly indumentum. Its unique position in the genus as the only species with a fleshy fruit explains, in some measure, its wide distribution, but its habitat-forms are a problem for physiological research.

In more sheltered positions, *Salvia aurea* Linn. becomes prominent, and when in flower, makes a conspicuous landmark, being one of the most attractive shrubs on the coast. It forms small associates with *Passerina rigida* Wikström.

The transition from this flora to the psammophilous macchia of the semi-fixed sand dunes is almost imperceptible and a fair amount of mingling of species does occur.

### PSAMMOPHILOUS MACCHIA AND LITTORAL SCRUB. (Coastal scrub on fixed or semi-fixed sand dunes.)

The coastal scrub on the sand dunes overlooking the sea has a fairly uniform outward appearance all along the south and east coast of South Africa. Due mainly to the effect of wind it has a regular, densely matted canopy from one to a few feet high. It is explained that the strong air currents along the coast exert almost continual pressure which greatly retards vertical elongation of the main stems and thus encourages lateral development, more especially in a landward direction. The stunted shrubs with intermingling branches are further bound together by numerous scandent shrubs and climbers, both woody

and herbaceous, resulting in an almost impenetrable thicket. Penetration is made even more arduous by the high percentage of spinescent shrubs. The deep troughs between the fixed dunes present a very different appearance, in that some of the species showing stunted growth on the exposed ridges, there attain heights up to 20 feet or more and the canopy is far less even and matted. On the succeeding ridge or ridges inland the stunted growth reappears but to a less marked degree. The composition of the flora is very heterogeneous and one rarely finds individual species dominant or even sub-dominant except occasionally in small areas. Arborescent succulents are relatively uncommon, yet the leaves of many shrubs tend to become somewhat fleshy, largely owing to the effects of the saline atmosphere.

Were it not for the interference of man there would be little change in this normally stable flora. Due mainly to firewood being chopped out, the hold of the roots on the sand has been considerably reduced in parts, and "blow-outs" are becoming increasingly serious. To a certain extent this has been checked by the spread of the exotic species, *Acacia saligna* Wendl. "Port Jackson Willow."

In the following lists of species the Dicotyledons and Monocotyledons are treated separately in families, more or less in alphabetical order. As shrubs and small trees predominate and are the essence of the formation, they are enumerated first, followed by climbers, herbs, etc. Except where otherwise mentioned, only species occupying an important part in the general constitution of the vegetation are listed.

#### *Shrubs and Trees.*

Anacardiaceae: *Rhus Schlechteri* Diels, *R. crenata* Thunb. on semi-fixed dunes, and *R. lucida* Linn.; Araliaceae: *Cussonia thyrsiflora* Thunb.; Boraginaceae: *Cordia caffra* Sond.; Capparidaceae: Although only a few species occur they are very important ecologically and one cannot penetrate far without encountering one or more of the following, *Maerua triphylla* Dur. and Sch., *M. racemulosa* Gilg & Bened., *Capparis oleoides* Burch., *C. Zeyheri* Turcz., *C. citrifolia* Lam., the last mentioned being particularly abundant and hindering greatly the traveller by its strong curved spines. Even more abundant numerically and specifically are the Celastraceae, represented by *Gymnosporia procumbens* Loesen., *G. undata* Szysz., *G. acuminata* Szysz., *G. nemorosa* Szysz., *G. heterophylla* Loesen., *G. burifolia* Szysz., *Pterocelastrus tricuspidatus* Sond., *Cassine sphaerophyllum* O.K., *C. aethiopicum* Thunb., *C. tetragona* Loesen. scandent shrub, *Putterlickia pyracantha* Endl. The last mentioned and a number of the species of *Gymnosporia* are spinescent. Since Compositae are predominately herbaceous or if woody, are small in habit, it is not surprising that they are not common in littoral scrub. As mentioned, however, they represent a fair percentage of the pioneer flora of the unstable sand dunes. *Brackylaena discolor* DC. is an important constituent and extends to the margin of the dune bush, *B. elliptica* Less. is also found and *Metalasia* sp. finds its way into the semi-fixed dunes. *Tarchonanthus camphoratus* Linn. is more suited to river bush. The heteromorphous and widely distributed species *Osteospermum moniliferum* has been mentioned previously and a few climbers are listed later.

Considering the frequency of Euphorbiaceae in inland vegetation, it is interesting that few species are found in the littoral scrub. Those present include *Croton rivularis* E. Mey. and the shrublets *Cluytia daphnoides* Lam. and *Phyllanthus heterophyllus* E. Mey. plus one or two herbs and climbers listed later. Others prefer the shelter of bush a little distance from the river mouths, for example *Euphorbia Burmanni* E. Mey. and *E. bubalina* Boiss. In addition,



the succulent, arborescent species of *Euphorbia* are usually abundant in this somewhat sheltered habitat, particularly *E. triangularis* Desf. and *E. tetragona* Haw., and less frequently *E. grandidens* Haw. These interesting plants often dominate the landscape owing to their numbers and their peculiar candelabra-like superstructures, which rise above the adjacent woody (as opposed to succulent) trees. All three of these species are tolerant of widely varying soil and moisture conditions, provided they receive a certain amount of protection either from other trees or from the contour of the hills. Near the coast they grow down to the water's edge, with their roots permanently wet, whereas a few miles further inland they are found on dry hillsides amongst karroid scrub receiving a rainfall of about 15 ins. per annum. Whether the saline conditions of the former habitat can be interpreted as resulting in a physiological drought requires further investigation.

The spinescent character of the littoral scrub is emphasised by four shrubs of Flacourtiaceae: *Doryalis rhamnoides* Harv., *D. rotundifolia* Harv., *Scolopia Ecklonii* Szysz. and *S. Zeyheri* Szysz., all of which have a scattered distribution. Leguminosae: *Schotia speciosa* Linn. and *S. latifolia* Jacq. are the only woody species. *Chiliantus arboreus* A.DC. in Loganiaceae, is fairly frequent, whereas *Lachnopylis emarginata* C.A. Sm. and *Strychnos spinosa* Lam. are rarer, as also *Turraa obtusifolia* Hochst. in Meliaceae. Loranthaceae: The parasites, *Loranthus elegans* Cham. & Sch. and *L. prunifolius* E. Mey. occur occasionally. Myrsinaceae: *Myrsine* (*Rapanea*) *Gilliana* Sond. is frequent or common and *Eugenia capensis* Harv., Myrtaceae, is no less important. Others are Oleaceae: *Jasminum angulare* Vahl with strongly scented white flowers, *Olea foveolata* E. Mey. and *O. exasperata* Jacq. Plumbaginaceae: *Plumbago capensis* Thunb., with light blue flowers, is comparable to "tecoma" as a hedge or ornamental shrub or Rambler. Polygalaceae: The spinescent shrublet *Mundtia spinosa* DC. is occasional in the fringing growth.

Rhamnaceae have *Scutia myrtina* Kurz., an important member of the community. It has hooked prickles and in this environment develops into a scrambling shrub interlocked with others, whereas in inland situations it is frequently found as a much-branched individual shrub. Rubiaceae: *Gardenia capensis* Druce, *Canthium obovatum* Klotzsch, *C. ventosum* Linn., *C. spinosum* O.K., *Pavetta capensis* Brem. and *P. revoluta* Hochst. Rutaceae: *Teclea natalensis* Engl. occurs generally, whereas *Fagara capensis* Thunb. and *Calodendron capense* Thunb. are more usually found amongst the river valley bush. Salvadoraceae: *Azima tetraacantha* Lam. Santalaceae: *Rhoiacarpus capensis* A.DC., *Osyris compressa* A.DC. Sapindaceae: *Allophylus erosus* Radlk. and *A. decipiens* Radlk. which is a common shrub with trifoliolate leaves is regularly mistaken for a species of *Rhus*, and *Hippobromus pauciflorus* Radlk. Sapotaceae: *Mimusops caffra* E. Mey. is another most important species in this community and follows the pioneers to the margin of the shifting dunes. *Dombeya tiliacea* Planch. (= *D. Dregeana* and *D. natalensis*) and *Clerodendron glabrum* E. Mey. are found occasionally.

Monocotyledons, excluding grasses, are relatively unimportant, and except for a few climbers and herbs, they do not influence the succession. *Dracaena Hookeriana* Koch, *Aloe africana* Mill. and *A. pluridens* Haw. are the only species to attain shrublike proportions.

#### *Climbers and Twiners.*

The climbers, twiners, etc., which play a noteworthy part in this community are: Asclepiadaceae: *Secamone Alpini* Schultes, *Astephanus marginatus*

Decne, *Cynanchum natalitium* Schlechter, *C. obtusifolium* L.f., *C. sarcostemmatoides* K. Schum., *Tylophora lycioides* Decne, *Fockea edulis* K. Schum. and *Riocreuria tortulosa* Decne. It will have been noted that no true shrubs were listed from this important family. Bignoniaceae: *Tecomaria capensis* Spach., a scandent shrub with scarlet flowers, is now cultivated throughout the country under the common name "tecaoma." A plant, similar in habit but not in beauty, is *Cassine tetragona* Loesen., Celastraceae. Compositae: *Microglossa mespilifolia* Robinson, *Senecio angulatus* L.f., *S. brachypodus* DC., *S. oryodontus* DC., *S. quinquelobus* DC. and *S. macroglossus* DC. The only species of Convolvulaceae to occur frequently is *Ipomoea ficifolia* Lindl. Cucurbitaceae: *Melothria punctata* Cogn. climber or creeper and *Coccinia quinqueloba* Cogn. Euphorbiaceae: *Dalechampia capensis* Spreng. f. Geraniaceae: *Pelargonium fruticosum* R. A. Dyer, scrambler. Solanaceae: *Solanum quadrangulare* Thunb., half succulent. Vitaceae are important numerically and functionally in that they assist very materially in binding together the shrubby constituents of this community, exposed as it is to the ferocity of the "south easter" winds. The species particularly concerned are, *Rhoicissus digitata* Gilg & Brandt, *R. cirrhiflora* Gilg & Brandt, and *R. dimidiata* Gilg & Brandt; others are *R. capensis* Planch. on taller trees, *Cissus cirrhoza* Willd. succulent. Zygophyllaceae: *Zygophyllum uitenhagense* Sond., has slightly fleshy leaves.

Climbing Monocotyledons are rare and the only noteworthy species are *Dioscorea sylvatica* Eckl., *Asparagus Kraussii* Baker, *A. medioloides* Thunb., two or three other species of the same genus, and *Behnia reticulata* Didrichs.

### Herbs.

Owing to the density of the canopy formed by the shrubs and climbers, light is cut off to a great extent from the undergrowth. In consequence there are comparatively few species except in places where partial clearing has taken place, either by the agency of man or by the grazing or trampling of animals. Acanthaceae are frequently represented, mainly by *Justicia Bowiei* C.B.Cl., *J. campylostemon* Anders., *Isoglossa ciliata* Lindau, *Hypoestes aristata* R. Br. and *H. verticillaris* R. Br. Campanulaceae are rarely abundant and apparently do not affect the succession materially, neither do the few species of Crassula, *C. perfoliata* Linn. and *Cotyledon* spp. occur more in the river bush and extend inland by this route. Compositae are mainly represented on the fringe and in clearings by *Senecio* spp., *Cineraria* spp. and *Aster* spp., some of which are common in small areas forming both consocieties and associates. Cruciferae: *Heliophila* spp. are found occasionally. Euphorbiaceae: A few species are locally abundant in well protected sites, e.g. *Adenocline acuta* Baill., *Leidesia obtusa* Müll. Arg., *Phyllanthus heterophyllus* Müll. Arg., *Euphorbia bubalina* Boiss., and *E. Burmanni* E. Mey., a scrambler in river scrub, also extends into inland karroid scrub. Gentianaceae: *Sebacia cleistantha* R. A. Dyer rather rare and *Chironia tetragona* L.f. Geraniaceae: *Pelargonium capitatum* Ait. Labiatae: *Salvia scabra* L.f. Leguminosae are very rarely represented in undergrowth. Malvaceae: *Pavonia praemorsa* Cav. is found frequently as a shrublet but may also develop into a tough shrub several feet high. Oxalidaceae: *Oxalis* spp. are occasional throughout and sometimes frequent locally. Rubiaceae are more common inland and *Rubia petiolaris* DC. is probably the most frequent at the coast. Scrophulariaceae: *Sutera* sp. and *Phyllopodium cuneifolium* Benth. on the fringe, *Manulea bellidifolia* Benth. and *M. obovata* Benth. Urticaceae: *Urtica Burchellii* N.E. Br., *Fleurya* sp. and *Droguetia Burchellii* N.E. Br. are uncommon.

*Monocotyledons.*

The Gramineae are the most important herbaceous Monocotyledons. The species, which are definitely associated with littoral scrub, do not, as a rule form a component part of the true undergrowth, but colonise clearings and the unstable fringe of the scrub. *Stenotaphrum secundatum* O.K. has been mentioned in connection with the halosere vegetation and another "lawn grass" is the fairly cosmopolitan *Dactyloctenium aegyptium* Richt., which also forms a dense sward on the fringe of bush or under tall trees where the canopy is not too dense. *Cynodon Dactylon* Pers. comes in strongly in many places, especially near settlements. *Digitaria littoralis* Stent is a strong runner and provides good stock feed in certain coastal areas. Other species present are: *Pentaschistis heptamcra* Stapf, *Polypogon tenuis* Brongn., *Paspalum* spp. exotics, *Aristida capensis* Thunb., which may be dominant in small areas, *Sporobolus* spp., *Diplachne fusca* Beauv., *Eragrostis* spp., *Ehrharta* sp., *Schismus koelerioides* Stapf and a few others. Restionaceae: *Restio Eleocharis* Nees is found frequently in clearings. Haemodoraceae: *Sansevieria thyrsiflora* Thunb. extends also inland in dryish areas. Orchidaceae are found occasionally, for example *Habenaria foliosa* Reichb. f., *Bonatea cassidea* Sond., *Satyrium parviflorum* S.W. and *S. sphaerocarpum* Lindl. Amaryllidaceae: *Clivia nobilis* Lindl., *Haemanthus puniceus* Linn., *H. albiflos* Jacq. are all frequent, especially in river bush. Liliaceae: *Gasteria acinacifolia* Haw., *Eriospermum* sp. nov. in grass on fringe of bush, *Anthericum* sp., *Albuca* sp., *Ornithogalum* spp., *Veltheimia viridifolia* Jacq. frequent in parts, *Scilla* spp. and *Gloriosa virescens* Lindl. rare.

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## **Chapter 5.**

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**FYNBOS.**

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## CHAPTER 5.

## FYNBOS (Specialised Inland Macchia).

Fynbos is a most interesting formation in the local vegetation for the reason that it is composed of the survivors of the south-western flora in competition with many pioneer types of a flora definitely of tropical or temperate origin. The area occupied is comparatively small and has decreased rapidly under present day methods of stocking and veld management. In this area fynbos is most commonly found on the margin of woods and forests on the south and south-western, usually rocky, slopes of the Zuurburg and Zwartwaterberg, and to a lesser extent on the parallel range a few miles further north. In its most characteristic form, fynbos is very dense, and is dominated by sclerophyllous shrubs belonging to the genera *Erica*, *Berzelia*, *Cliffortia*, *Passerina*, *Aspalathus*, *Metasia*, etc. Smaller members of bush and low forest, although often associated with fynbos, are not considered as typical of it and have been largely excluded from the list of species enumerated later. It may be assumed with fair certainty that fynbos, in the absence of interference by man, would, in the majority of areas, be succeeded eventually by pioneers of bush of tropical or temperate origin. There are a few temperate, shallow valleys and hillsides where *Erica* spp., etc., are dominant and appear to be spreading, and in these areas one usually finds bush types slightly lower in the valley or in adjacent protected kloofs. Veld fires followed by heavy stocking by sheep have done inestimable damage to this formation.

Although fynbos is characteristic of temperate habitats, some sclerophyllous species are hardier than others and penetrate to the margin of scrub veld, where they may form consocieties or associations over limited areas.

*Passerina vulgaris* Thoday is adapted to a wide range of conditions, and is found frequently as a dominant or subdominant in broken grassveld near bush and in dryish places with little undergrowth. Consocieties of this species occur on the hills south-west of Grahamstown, and, to the north, on parts of the rocky south slope of Bothas ridge, it forms associations with *P. obtusifolia*. *Aspalathus* spp. also are found somewhat frequently on open dryish flats a few miles north of Grahamstown and, when in flower, give the veld the appearance of English "gorse" country.

The nature reserve on the south-western slope of the Mountain Drive, Grahamstown, was established primarily for the preservation of an "outlier" community of typical south-western flora. Mr. C. D. B. Liebenberg, Government Botanist, Grahamstown, has made some very useful records in this particular area.

In reviewing the composition of the local fynbos, the families of Dicotyledons are arranged alphabetically followed by the Monocotyledons, and ecological notes are included throughout.

*Dicotyledons.*

Bruniaceae: This family, typical of the south-western Cape flora, is represented by *Berzelia commutata* Sond. and *B. intermedia* Schlechter which are frequent, often dominant, over small areas forming close consocieties and associations with *Erica demissa* Klotz.

Campanulaceae: These herbs, especially *Wahlenbergia* spp. and *Lobelia* spp. are found on the margin of fynbos in temperate habitats; the slender twiners *Cyphia undulata* Eck., *C. sylvatica* Eck., and *C. heterophylla* Presl., make use of the small shrubs for support.

Compositae: It may be said that Compositae make their final bid for dominance in this transitional stage in the succession to bush, in which very few are able to survive on account of the height and density of bush; many species compete with the sclerophyllous shrubs of the south-western Cape flora which usually dominate the fynbos. The most frequent are *Vernonia corymbosa* Less., *Conyza ivifolia* Less., *C. ulmifolia* O.K., *Schistostephium crataegifolium* Fenzl., *Artemisia afra* Jacq., *Athanasia dentata* Linn., *A. pinnata* L.f., *Eriocephalus umbellulatus* Cass., in somewhat dry places, *Helipterum milleflorum* Druce, *Helichrysum adscendens* Less., *H. odoratissimum* Less., *H. niveum* Less., *H. ericifolium* Less., *H. petiolatum* DC., *Athrixia heterophylla* Less., *Stoebe cinerea* Thunb., *Metalasia muricata* R. Br., very variable in size, a small to large shrub often subdominant over moderate areas, *Relbunium trinervis* Thunb., *R. pungens* L'Herit., *Osteospermum moniliferum* Linn., *O. junceum* Berg., *O. grandidentatum* DC., *Cineraria lobata* L'Herit., *C. sarifraga* DC., *C. Britteniae* Hutch. & Dyer, *Senecio rosmarinifolius* L.f., *S. juniperinus* L.f., *S. ilicifolius* Thunb., and *S. rigidus* Linn.

Ericaceae: About a dozen species of this family, characteristic of the south-western Cape flora, occur in Albany and Bathurst, all of which belong to the genus *Erica*. *E. Chamissonis* Klotz, *E. caffra* Linn., *E. demissa* Klotz, *E. nemorosa* Klotz, *E. calycina* Linn. and *E. unilateralis* Klotz are common or dominant in parts, and give character to the local fynbos. *E. glumifera* Klotz and *E. cerinthoides* Linn. are common, small pioneers of this community, and are more fire resistant than the others. *E. curviflora* Linn. and *E. orientalis* R. A. Dyer are comparatively rare but consociates and associates of them do occur in shallow temperate valleys towards the coast. *E. caffra* may be found also in mixed bush up to about 12 ft. high.

Euphorbiaceae: These are frequent, particularly on the margin of this formation. The shrubs and undershrubs more commonly found are: *Cluytia ericoides* Thunb., *C. lara* E. & Z., *C. alaternoides* Linn., *C. pulchella* Linn., *C. affinis* Sond., *C. Dregeana* Scheele, *C. hirsuta* E. Mey., *Phyllanthus maderaspatensis* Linn., *P. incurvus* Thunb., *Euphorbia Kraussiana* Bernh., *E. erythrina* Link., *E. epicyparissias* E. Mey., and *E. ericoides* Lam.

Gentianaceae: A few species of *Chironia* and *Sebaea* are present in the mixed growth on the fringe of fynbos. *Chironia melampyryfolia* Lam. is the commonest and when in flower is a most conspicuous scrambler.

Geraniaceae: The half shrubs, *Pelargonium Radula* L'Herit., *P. graveolens* L'Herit., and *P. populifolium* E. & Z. are frequently associated in fynbos on the margin of bush, or may also occur as isolated plants in open situations. The herbs *P. odoratissimum* Ait. and *P. grossularioides* Ait. occur in the short fringing growth.

Labiatae: These herbs are mostly on the fringe, *Salvia obtusata* Thunb., *S. aurita* L.f., *S. runcinata* L.f., *S. repens* Burch., *Stachys aethiopica* Linn., *Plectranthus ciliatus* E. Mey. and *P. Ecklonii* Benth. The subshrubs *Leonotis Leonurus* R. Br., *L. Leonitis* R. Br. and *L. dubia* E. Mey. penetrate further.

Laurinaceae: *Cassytha ciliolata* Nees is parasitic on *Barosma venusta* E. & Z. and possibly other species.

**Leguminosae:** A large number of species enter into the composition of this community, many of which are definitely of sub-tropical origin, while others are outliers of the south-western flora. Those belonging to the latter category include *Podalyria velutina* Burch., *P. Burchellii* DC., *P. cuneifolia* Vent., *Priestleya hirsuta* DC., *Aspalathus setacea* E. & Z., *A. polioties* E. & Z., *A. adelphica* E. & Z., *A. microdon* Benth., *Psoralea glabra* E. Mey. (= *P. pinnata* forma ?), *P. oligophylla* E. & Z., *P. affinis* E. & Z., *P. capitata* L.f., *P. polyphylla* E. & Z., *P. decumbens* Ait., and *P. tomentosa* Thunb. Those of subtropical origin include *Lotononis cytisoides* Benth., *Buchenrodera multiflora* E. & Z., *Indigofera cuneifolia* E. & Z., *I. sulcata* E. & Z., *I. stricta* E. & Z., *I. polioties* E. & Z., *Tephrosia polystachya* E. Mey., *T. grandiflora* Pers., *Crotalaria capensis* Jacq., *Calpurnia sylvatica* E. Mey. and the climbers or ramblers *Vigna helicopa* Walp., *Dolichos gibbosus* Thunb., *Rhynchosia hirsuta* E. & Z., *R. caribaea* DC., *R. capensis* Schinz.

**Loganiaceae:** *Chilianthus arboreus* A.DC., *C. lobulatus* A.DC., and *C. dysophyllus* A.DC. occur occasionally, the first being fairly widespread in temperate and dry areas along the coast and inland.

**Myricaceae:** Two species of *Myrica*, another genus of shrubs characteristic of the south-western Cape flora, *M. quercifolia* Linn. and *M. conifera* Linn. occur occasionally, being frequent in small areas.

**Myrsinaceae:** *Myrsine africana* Linn. is frequent or common and is found on the margin of forests throughout South Africa.

**Polygalaceae:** *Polygala oppositifolia* Linn. and *P. virgata* Thunb. are frequent, and *P. myrtifolia* Linn. also, but in more open positions. The genus *Muralia*, of south-western Cape flora relationship, is often conspicuous in temperate grassveld. *M. squarrosa* DC., *M. alopecuroides* DC., and *M. ericifolia* DC. are pioneers of fynbos and may form close associates, being part of the first growth after veld fires.

**Proteaceae:** *Protea cynaroides* Linn. and *P. repens* Linn. are fairly frequently associated with fynbos and *Leucadendron salignum* Berg. is common; *Protea macrophylla* R. Br. is frequent along some slopes of the Zuurberg and Zwartwaterberg but is not usually densely surrounded by typical fynbos growth, and *L. ellipticum* R. Br. (not of Fl. Cap.) (= *L. attenuatum* of Fl. Cap.) is occasional and forms an isolated consociation in grassveld in Trappes Valley.

**Rhamnaceae:** *Phylica paniculata* Willd., *P. lutescens* Sond. and *P. gnidioides* E. & Z. often form consociations and are a further link with the south-western Cape flora.

**Rosaceae:** The genus *Cliffortia*, which has its greatest concentration in the south-western Cape, is represented by nine species, *C. serpyllifolia* Cham. & Schidl. and *C. strobilifera* Murr. being common, often forming consociations or associates with *Erica* spp. and *Anthospermum* sp. In the herbaceous fringing growth there are *Alchemilla capensis* Thunb., *A. elongata* E. & Z. and *Geum capense* Thunb., and occasionally the ramblers *Rubus pinnatus* Willd. and *R. rigidus* Suv.

**Rubiaceae:** The more important species in fringing growth are the undershrubs: *Anthospermum aethiopicum* Linn., *A. paniculatum* Cruse and *Spermacoce natalensis* Hochst.

**Rutaceae:** The frequency of certain Rutaceae in this formation is yet another link with the flora of the south-western Cape. *Barosma venusta* E. & Z. forms dense consociations, while *B. scoparia* E. & Z. and *B. lanceolata* Sond. are common, but usually associated with low shrubs of tropical affinity. Several species of *Agathosma* occur in the marginal growth and spread somewhat into grassveld



as pioneers of fynbos, viz. *A. barosmoides* Sond., *A. mixta* Dummer, *A. Owanii* Harv. & Sond. *A. clavisepala* R. A. Dyer is frequent in small areas in low scrub.

Santalaceae: Scattered specimens of *Thesium* spp. occur on the fringe and *T. fruticosum* A. W. Hill within the formation. *Osyris compressa* A.DC. is more characteristic of low bush or scrub.

Selaginiae: Species of *Walafrida* occur on the fringe; *Selago corymbosa* Linn. is common and spreads in certain grassveld stocked with sheep. An experiment was conducted to investigate possible means of control and results were published in *Farming in South Africa*, 1932.

Scrophulariaceae: Not very characteristic of the formation but such species as *Freylinia undulata* Benth. and *Phyggeius acqualis* Harv. are occasional.

Sterculiaceae: A number of species of *Hermannia* occur, especially in the shorter fringing growth.

Thymelaeaceae: *Passerina vulgaris* Thoday frequently forms consocieties near bush and is widely distributed. It occasionally forms associates with *P. obtusifolia* Thoday on dryish hillsides. *Gnidia oppositifolia* Linn., *Struthiola MacOwani* C. H. Wright and *S. parviflora* Bartl. are in fringing growth often near streams; *Lasiosiphon anthylloides* Meisn., *L. capitatus* Burt Davy and *Gnidia* sp. may be present and also spread into open grassveld.

Umbelliferae: *Peucedanum capense* Sond., *P. connatum* E. Mey., *Rhyticarpus rugosus* Sond., *R. difformis* Benth. and Hook. f., *Lichtensteinia interrupta* E. Mey., *Alepidea capensis* (Berg.) R. A. Dyer and *Hydrocotyle virgata* L.f. are representative and are usually found as scattered individuals.

### *Monocotyledons.*

On the margin of fynbos and in places where the growth is not too dense some grasses persist. In these areas the succession is very largely influenced by man. Under natural conditions the fynbos would gradually take possession of more grassveld, but, due to overstocking and veld fires, the fynbos is not only held in check but is destroyed at a greater rate than regeneration can take place. The result is that fynbos is gradually disappearing from the margin of bush, giving rise to the impoverishment of the bush and causing conditions encouraging soil erosion.

A considerable number of Monocotyledons from the Orchidaceae, Liliaceae, Iridaceae and Amaryllidaceae are associated with fynbos, on the fringe or where the growth is comparatively short. They appear to be intruders of comparatively little ecological importance. To mention a few: *Satyrium maculatum* Burch., *S. membranaceum* Sw., *Albuca altissima* Dryand., *Hesperantha falcata* Ker, *Aristea* sp., *Watsonia Meriana* Miller, *Antholyza caffra* Ker, *A. aethiopica* Linn., *Hypoxis* spp. and *Tulbaghia* spp.

Restionaceae have their greatest concentration in the south-western Cape. In local fynbos they are in relation to Monocotyledons, what the Ericaceae, Bruniaceae, etc., are to Dicotyledons. Some are more typical of very sour grassveld than fynbos, but on the whole are more closely associated with the latter, particularly on the somewhat protected rocky slopes and kloofs of the Zuurberg. The important species are: *Restio fruticosus* Thunb., *R. Rhodocoma* Mast., *R. triticeus* Rottl., *Elegia asperifolia* Kunth, *Leptocarpus paniculatus* Mast., and *Cannomois virgata* Steud.

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## Chapter 6.

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SCRUB, INLAND SCRUB, BUSH AND LOW FOREST.

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## CHAPTER 6.

## SCRUB.

Scrub is a term interpreted slightly differently by different authors. Generally speaking the most characteristic features are an abundance of shrubs and stunted trees; prevalence of spinescent forms; the presence of succulents and the absence of dominance. It has been found convenient by different authors to recognise different scrub types, such as *littoral scrub*, *inland scrub*, *karroid scrub*, etc. The first two types result from habitat modifications of a similar flora; they are a transitional stage in the succession towards a climax bush or forest flora, or the more xerophytic members may play an important part in the colonisation of dry areas in which karroid scrub is the climax. Karroid scrub is distinguished from the other two types mainly by the greater concentration of shrubby succulents and spinescent plants, and the almost complete exclusion of mesophytes. Littoral and inland scrub and bush, similar to the local examples, have been dealt with fairly fully by Phillips (1931) whereas typical karroid scrub did not come within the scope of his work. Other authors also have given greater attention to scrub in the general sense. For this reason karroid scrub will be treated later in some detail. Phillips (l.c.) points out that scrub may develop either from macchia on the coast or inland, and that bush differs from scrub primarily in its physiognomy; bush assumes the aspect of what might be considered either very luxuriant scrub or short, poorly-developed forest, i.e. bush is the transitional stage between scrub and forest.

The general composition of transitional scrub may be gathered by a study of the sections dealing with *Pioneer Littoral Scrub*, *Inland Scrub*, *Bush and Forest* and *Karroid Scrub*. In the respective lists of species those characteristic of scrub in general are usually commented upon. The presence of the arborescent succulent species of Euphorbia, *E. triangularis* Desf., *E. tetragona* Haw., and *E. grandidens* Haw. is often an indication of approaching karroid conditions, but not invariably so, as these trees are tolerant of both temperate and dry conditions.

## INLAND SCRUB, BUSH AND LOW FOREST.

The area covered by these vegetation types is fairly extensive. The river valleys, from the coast inland to the Zuurberg extension, Zwartwaterberg, are, for the most part, densely wooded. Towards the coast the main river valleys are all comparatively narrow and steep-sided, and most of them continue so for the greater part of their length. The Fish River, however, widens out considerably about 15 miles from the coast and the vegetation is then of the karroid scrub type for many miles further inland. This is discussed later. The Bushmans River valley also penetrates some distance inland through the Zuurberg extension near Alicedale. Two of its tributaries rise on the watershed near Riebeeck East and flow for a number of miles in opposite directions. Some stretches, particularly near Alicedale, are colonised by similar karroid scrub to that found in the Fish River valley. Succulents are usually fairly conspicuous on all rocky slopes and krantzies. For the rest, the vegetation is of a medium scrub or bush type, the height and density of which is largely dependent on the rainfall, soil and exposure.

The rainfall within the various valleys is usually lower than on the flats and the temperatures are higher, resulting in a low humidity, conditions unfavourable for forest growth. Forest types do occur, but not until the higher, more temperate and humid ravines of the Zuurberg and Zwartwaterberg are reached is there development of typical low forest growth. Patches of low forest are also found in the kloofs of the mountain range north of and parallel to the Zwartwaterberg. In the majority of cases forest patches are restricted to the southern exposures: on the open hillsides and on northern exposures scrub and grassveld predominate.

In common with scrub, local bush and forest show a lack of dominance, although naturally some species are more common than others, as is indicated in the list given below. Scrub, bush and forest are often in intimate association, scrub being the marginal growth of stream-bank bush and low forest.

Fynbos also should be regarded as a transitional stage in the succession towards bush and forest types. Although bush locally is not always associated with fynbos, fynbos is rarely found unassociated with bush, and would eventually, in the absence of other extraneous interference, be replaced by it. The sub-tropical elements in fynbos, as recorded in this work, are at the same time pioneers of a bush flora.

Separating the river valleys there is undulating grassveld. Where this is interrupted by ridges, the slopes are frequently wooded with scrub growth. Scrub pioneers in open grassveld are uncommon, although *Acacia Karroo* Hayne, *Royena* sp. and *Euclea* sp. may become prominent, especially under conditions of faulty veld management. Before the advent of the white settlers most of the scrub and bush in the valleys was almost impenetrable but during the past 100 years considerable thinning has taken place by chopping-out and grazing.

Since the inter-relationship between scrub, bush and forest is so intimate the more important species are included in one list with amplifying ecological notes. Species found in the undergrowth are listed separately, followed by Monocotyledons and Filicales.

#### WOODY, CANOPY-FORMING COMPONENTS AND SOME ASSOCIATES.

##### *Gymnosperms.*

Taxaceae: *Podocarpus falcatus* R. Br. and *P. latifolius* R. Br. were more important originally than they are to-day. Fair sized trees with trunks up to 20 ft. in circumference still exist in sheltered forests and bush, but the majority were felled for building purposes by early colonists. Regeneration, although very slow, may be found in woods not too disturbed by stock.

##### *Dicotyledons.*

Anacardiaceae: These are numerically important in bush, represented by *Lorostylis alata* Spreng., *Harpephyllum caffrum* Bernh., *Rhus Legati* Schönl., all three being found also in low forest; others are *Rhus MacOwani* Schönl., characteristic of stream-bank bush, *R. dentata* Thunb., *R. undulata* Jacq., *R. lucida* Linn., *R. glauca* Desf., and *R. tomentosa* Linn.

Araliaceae: *Cussonia spicata* Thunb., widely distributed and suited to karroid scrub, bush, or low forest conditions.

Asclepiadaceae: This family contributes many important climbers, some of which are recorded also for the sand-dune scrub: *Secamone Alpini* Schultes, *S. frutescens* Decne, *Cynanchum obtusifolium* L.f., *C. ellipticum* (Harv.) R. A.

Dyer (= *C. capense*), *Tylophora cordata* Druce, *T. umbellata* Schlechter, rare, *Sarcostemma viminalis* R. Br., a leafless climber found also in dry scrub, *Marsdenia floribunda* N.E. Br., frequent in both bush and low forest, *Fockea edulis* K. Schum., rare, more common in dry scrub, *Riocrexia tortulosa* Decne.

Aquifoliaceae : *Ilex mitis* Radlk., frequent in forest.

Bignoniaceae : *Tecomaria capensis* Spach., a scandent shrub characteristic of bush towards the coast, occasional elsewhere.

Boraginaceae : *Ehretia rigida* Druce, present but more frequent in dry scrub.

Capparidaceae : *Maerua triphylla* Dur. & Sch., a shrub or small tree, is common, *M. racemulosa* A.P.DC., and *Capparis oleoides* Burch. are rarer, all three being constituents also of the sand-dune scrub.

Celastraceae : These are important mostly in scrub and bush, both numerically and specifically ; those most commonly met with are *Gymnosporia polyacantha* Szysz., *G. burifolia* Szysz., *G. angularis* Sims, *G. acuminata* Szysz., *G. peduncularis* L. Bolus, *G. nemorosa* Szysz., *Pterocelastrus tricuspidatus* Sond., *Cassine Kraussiana* Bernh., *C. latifolia* E. & Z. scandent, *C. tetragona* Loesen. scandent, and *Putterlickia pyracantha* Endl.

Compositae : *Brachylaena elliptica* Less. and *Tarchonanthus camphoratus* Linn. are the only really woody species of sufficient size to invade inland bush, although the ubiquitous *Osteospermum moniliferum* Linn. occurs near the margin up to about 12 ft. high. Climbers such as *Senecio deltoideus* Less., *S. mikanioides* Otto, *S. quinquelobus* DC., *Microglossa mespilifolia* Robinson, and *Mikania capensis* DC. are frequent.

Ebenaceae : *Royena pubescens* Willd., and particularly *R. pallens* Thunb. are pioneers of bush clumps and are later crowded out by larger species. *R. villosa* Linn. a rambling shrub, *R. cordata* E. Mey., *R. lucida* Linn., *Euclea undulata* Thunb., *E. lanccolata* E. Mey., and *E. multiflora* Hiern are also present.

Euphorbiaceae : No truly woody trees occur, but, as pointed out, the arborescent succulent species *Euphorbia tetragona* Haw. and *E. triangularis* Desf. are adaptable to widely different habitat conditions and are often conspicuous in woods on fairly steep slopes. *Cluytia pulchella* Linn. is found on the margin of bush or along streams.

Flacourtiaceae : *Kiggelaria africana* Linn. is frequent in dense woods and low forest ; smaller trees or shrubs are *Scolopia Mundtii* Warb., and three spinescent species which occur also in sand dune bush, *S. Ecklonii* Szysz., *S. Zeyheri* Szysz., and *Dovyalis rhamnoides* Harv.

Geraniaceae : A few species of *Pelargonium* occur on the fringe, but the climber *P. peltatum* Ait. is the only one to penetrate further, even this is more at home rambling over dry scrub bush.

Hamamelidaceae : *Trichocladus ellipticus* E. & Z. is frequent in forest and develops into a large tree under favourable conditions.

Icacinaeae : *Apodytes dimidiata* E. Mey. and *Cassinopsis ilicifolia* O.K. are both important constituents of bush and low forest, the former, however, is less frequent here than in other forest areas.

Leguminosae : A number of small shrubs and half shrubs are in the vegetation fringing bush and have been referred to under fynbos ; only two species of *Schotia*, *S. latifolia* Jacq. and *S. speciosa* Linn. are definitely of this formation, although the latter is more characteristic of karroid scrub. *Acacia Karroo* Hayne is more of a pioneer and only remains on the margin of bush or where

the bush is fairly open. The spinescence varies greatly according to habitat and age : young trees along hot, usually dry watercourses have very much larger spines than trees in temperate situations, and older trees usually have comparatively small spines. *A. caffra* Willd. is usually restricted to river bush, particularly in hot valleys.

**Loranthaceae :** This family of parasites is well represented in scrub and bush by the woody species *Loranthus elegans* Cham. & Schlecht. and *L. prunifolius* E. Mey., and by the semi-succulent species *Viscum obscurum* Thunb., *V. rotundifolium* L.f. and *V. capense* L.f. which germinate on a variety of shrubs, often *Rhus* spp.

**Meiaceae :** *Placoxylon obliquum* Radlk. (= *P. utile* E. & Z., sneezewood) is far less common in scrub and bush to-day than it was a century ago. It has been used very extensively for fencing poles, etc., in consequence few trees of any size remain. *Ekebergia capensis* Sparm. is fairly frequent but of less importance.

**Moraceae :** There are three "wild fig" trees, *Ficus capensis* Thunb., *F. Burtt-Davyi* Hutch., and *F. ingens* Miq., the first two being fairly frequent in such places as Howiesons Poort.

**Myrsinaceae :** *Myrsine* (*Rapanea*) *melanophloeos* R. Br. is an important constituent of bush and low forest and is frequent or common in the moister areas. *M. Gilliana* Sond. does not extend further than the coastal bush.

**Myrtaceae :** *Eugenia Zeyheri* Harv. is frequent or occasionally common and reaches a height of 30 ft. or more.

**Ochnaceae :** Both *Ochna arborea* Burch. and *O. atropurpurea* DC. are frequent, the former penetrating taller bush and forest than the latter.

**Oleaceae :** *Jasminum angulare* Vahl, a rambler with sweetly scented flowers, is frequent, *J. multipartitum* Hochst. occasional. *Olea laurifolia* Lam is an important forest tree and *O. verrucosa* Link. is found in scrub.

**Oliniaceae :** *Olinia cymosa* Thunb. is fairly frequent.

**Pittosporaceae :** *Pittosporum viridiflorum* Sims is an important member of both bush and forest growth.

**Plumbaginaceae :** The rambler *Plumbago capensis* Thunb. is occasional, and more common in scrub bush.

**Ranunculaceae :** Two climbers, *Clematis brachiata* Thunb. and *C. triloba* Thunb. are conspicuous in woods when in flower ; some botanists consider them forms of one species.

**Rhamnaceae :** The ubiquitous *Scutia myrtina* Kurz is common, *Rhamnus prinoides* L'Herit. occasional, *Noltea africana* Reichb. and *Helinus integrifolius* O.K. rare.

**Rubiaceae :** Important trees are *Rothmannia capensis* Thunb. (= *Gardenia Rothmannia* L.f.), *Canthium obovatum* Klotzsch, *C. ventosum* O.K., and *C. Mundtianum* Cham. & Schl. The following are smaller trees or shrubs : *Burchellia bubalina* Sims, *Gardenia capensis* Druce (= *G. Thunbergia* L.f.), *Randia rudis* E. Mey., *Canthium ciliatum* O.K., *C. spinosum* O.K., *Pavetta capensis* Brem., *P. lanceolata* Eckl., and *Psychotria capensis* Vatke.

Rutaceae: Species of *Barosma* and *Agathosma* are frequent in fynbos, often fringing bush; the trees *Clausena inaequalis* Benth., *Fagara capensis* Thunb., *Teclea natalensis* Engl., *Calodendron capense* Thunb., are all important in bush and forest.

Samydaceae: *Trimercia trinervis* Harv. and *T. grandifolia* Warb. are occasional.

Santalaceae: *Osyris compressa* A.DC., *Rhoiacarpos capensis* A.DC., and *Osyridicarpos natalensis* A.DC. occur in low bush or scrub.

Sapindaceae: *Allophylus decipiens* Radlk., *A. crosus* Radlk., the former widely spread the latter restricted to coastal bush, *Hippobromus pauciflorus* Radlk. frequent or common.

Sapotaceae: *Sideroxylon inerme* Linn. frequent.

Saxifragaceae: *Cunonia capensis* Linn. occasional, large tree in forest.

Solanaceae: Some species of *Lycium* occur on the margin of bush or scrub.

Scrophulariaceae: *Halleria lucida* Linn., a rambling shrub, frequent.

Tiliaceae: *Grewia occidentalis* Linn., rambling shrub, frequent.

Umbelliferae: *Heteromorpha arborescens* Cham. & Schlecht. is a weak rambling shrub of wide distribution, though not very common.

Verbenaceae: *Clerodendron glabrum* E. Mey., in coastal bush; *Lantana salvifolia* Linn. and *Lippia asperifolia* Rich. are subshrubs found on the fringe of bush or scrub, but do not enter into true fynbos or bush growth.

Vitaceae: These robust climbers are of importance and often cover the tops of high trees. *Rhoicissus capensis* Planch., *R. dimidiata* Gilg. & Brandt, *R. cirrhiflora* Gilg & Brandt, *R. cuneifolia* Planch., *R. rhomboidea* Planch. and *R. digitata* Gilg & Brandt, are all frequent or common locally.

#### UNDERGROWTH.

Acanthaceae: These are characteristic of the undergrowth flora, and the following are occasional or frequent: *Justicia protracta* And., *J. capensis* Thunb., *Isoglossa ciliata* Lindau, *I. Eckloniana* Lindau, *I. MacOwani* C.B.Cl., *Peristrophe cernua* Nees; *Hypoestes aristata* R. Br. and *H. verticillaris* R. Br. are both common and often dominant.

Compositae: Mostly indirectly associated and are listed in the chapter on fynbos.

Crassulaceae: It is hardly correct to consider species of *Crassula* as components of bush undergrowth, yet a number of species are found in such places as sheltered rock ledges within bush areas, to which light has fair access. The following examples are frequent or common: *C. filamentosa* Schonl., *C. lactea* Ait., *C. multicava* Lem., *C. cordata* Thunb., *C. nemorosa* Endl., *C. rosularis* Haw., *C. intermedia* Schonl.

Cruciferae: *Cardamine africana* Linn. is characteristic of the undergrowth in woods and forest.

Ficoidaceae: This family, rich in succulent forms, like Crassulaceae, penetrates low bush and temperate scrub where the shade is not very dense on rock ledges, etc. Relatively few species, however, are recorded and belong mostly to the genus *Delosperma* (a sub-division of the large genus *Mesembryanthemum*).



Fumariaceae: *Phacocarpus Cracca* Bernh. is characteristic of forest undergrowth and *P. pruinosa* Bernh. is rare.

Gesneriaceae: Both *Streptocarpus Rexii* Lindl. and *S. parviflorus* Drege occur frequently, usually on moist shady krantzies.

Labiatae: Species which often form small consocieties and associates in bush and forest undergrowth are *Plectranthus laxiflorus* Benth., *P. Thunbergii* Benth., and *P. Ecklonii* Benth. Other species requiring more light find a place on the fringe.

Malvaceae: Species of *Hibiscus*, *Pavonia*, *Abutilon* and *Malvastrum* occur in mixed fringing growth and many of them spread readily in disturbed areas.

Oxalidaceae: Most species of *Oxalis* favour open veld but some are found occasionally under the protection of trees in part shade.

Passifloraceae: *Ceratiosicyos Ecklonii* Nees is a fairly rare herbaceous climber.

Piperaceae: The solitary species *Peperomia reflexa* A. Dietr. is common on moist rock ledges, on old stumps of trees, and similar situations.

Rubiaceae: *Galopina circaeoides* Thunb., *Anthospermum herbaceum* L.f., *Galium mucroniferum* Sond. are all frequent or common in limited areas.

Scrophulariaceae: A few species such as *Teedia lucida* Rudolphi, *Diclis reptans* Benth., *Nemesia melissifolia* Benth. and *Sutera* spp. occur in shady woods.

### *Monocotyledons.*

The presence in the Bathurst division of the palm, *Phoenix reclinata* Jacq., which has evidently extended its distribution from Tropical Africa, is interesting. It occurs along the banks of the Kap River (tributary of the Fish River) and is also found in Lushington Valley, the southernmost record, and in all probability the locality from which the type material was collected over 100 years ago by the Viennese gardeners Boos and Scholl. (Figs. 10 and 11.)

Agavaceae: *Dracaena Hookeriana* Kock, which occurs in bush and forest, has a stout fibrous stem a few feet high but does not reach higher than the middle story.

Gramineae: The robust grasses, such as *Hyparrhenia hirta* Stapf and *Cymbopogon prolixus* Phill. form a transitional stage in the succession from short grassveld to bush. *Panicum maximum* Jacq., *P. decustum* Thunb. and *Ehrharta erecta* Lam. enter forest glades and *Oplismenus hirtellus* Beauv. is frequent in undergrowth.

Iridaceae: *Lapeyrouisia cruenta* Baker is frequent in glades of bush and forest. *Haemanthus puniceus* Linn., *H. magnificus* Herb. and *Clivia nobilis* Lindl. are frequent in coastal bush.

Liliaceae: The arborescent species of *Aloe*, *A. pluridens* Haw. and *A. africana* Mill. are frequently associated in scrub patches; *A. ferox* Mill. may be in open scrub but is more typical as a dominant or sub-dominant on koppies. *Agapanthus africanus* Hoffmg.\* (*A. umbellatus*) is occasional in forest and sometimes locally abundant. *Asparagus* spp., *Bulbine alooides* Willd., *Anthericum* sp., *Chlorophytum elatum* R. Br. and *C. comosum* Baker are occasional or frequent. The frequency of the bulbous plants increases in more open places with a lower rainfall.

\* *Agapanthus* and *Tulbaghia* transferred from Amaryllidaceae to Liliaceae by Hutchinson, 1934.

Orchidaceae: Among the orchids the epiphytic species are the most characteristic of bush and forest and three or four of the following may be found on a single tree of *Podocarpus* (yellow wood): *Angraecum succiferum* Lindl., *A. pusillum* Lindl., *A. bicaudatum* Lindl., *A. mystacidii* Reichb. f. and *Mystacidium filicorne* Lindl. *Polystachya ottoniana* Reichb. f. and *P. pubescens* Reichb. f. occur on old stumps and moss-covered rocks; in glades or mossy rock ledges, etc., one may find *Liparis Bowkeri* Harv., *Acrolophia cochlearis* Schl. & Bolus, *Bartholina Lindleyana* Reichb. f., *Stenoglottis fimbriata* Lindl., *Bonatea cassidea* Sond., *B. Boltoni* Bolus and *B. speciosa* Willd.

### *Filicales.*

The ferns are characteristic of bush and forest undergrowth, particularly along the cool streams, on old stumps and near waterfalls: the more frequent are: *Trichomanes pyridiferum* Linn., *Hemitelia capensis* Br. "tree fern" of particular beauty, *Dryopteris inaequalis* O.K., *Asplenium praemorsum* Sw., *A. bipinnatum* C. Chr., *A. theciferum* Mett., *A. solidum* O.K., *A. cuneatum* var. *splendens* O.K., *Polytrichum* sp., *Ceterach cordata* Desv., *Polypodium lanceolatum* Linn., *Pteridium aquilinum* Kuhn. "bracken," *Pellaea viridis* Prantl, *Nothochlaena Eckloniana* O.K., *Blechnum punctulatum* Swartz var., *B. capense* Sch., *Mohria caffrorum* Desv. and *Todea barbara* Moore.

*Lycopodium gnidioides* Linn. and *L. clavatum* Linn. are also frequent or common, rooting in leaf mould.



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## Chapter 7.

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### KARROID SCRUB :

Main Factors determining Evolution in Karroid Areas :  
Rainfall.  
Temperature.

#### Main Evolutionary Tendencies of Plants :

1. Tolerance of a Wide Range in Temperature.
2. Economy of Water.
3. Power to Profit by Rainfall.
4. Power to Survive Desiccation.
5. Viable Seeds, Annuals.
6. Conservation of Water, Succulence.
7. Spinescence.

### KARROO VELD (two Charts).

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## CHAPTER 7.

## KARROID SCRUB.

Karroid scrub is a vegetation type characteristic of a wide area of the eastern Cape, particularly in the hot dry valleys of the Sundays, Bushmans and Fish Rivers. It is developed to a less pronounced degree in similar parts of river valleys somewhat to the west (Gamtoos) and to the east in Natal (Kei, Umkomaas, Tugela, etc.). Most of the shrubby species present in the eastern Cape have migrated from the subtropical flora in Natal and further north. The succulent species also are from subtropical stock but their greater plasticity has resulted in the evolution of new forms during migration. The colonisation of new and more favourable areas for the spread and competition of succulent plants with woody plants has resulted in succulents frequently attaining dominance in karroid scrub. This state is never found in scrub which forms a transitional stage to bush and forest. The great abundance of succulent plant forms, therefore, is the main distinguishing feature of karroid scrub. Further, as compared with ordinary scrub, there is a greater development of spinescence, a decrease in the number of species, a retarding of regeneration, and, in disturbed areas, a succession towards Karroo conditions with the percentage of *dwarf* shrublets increasing.

The study of karroid scrub, as a climax community in Albany, has been largely restricted to the valleys of the Fish River and its tributary the Koonap River, extending to within about 15 miles of the mouth of the great Fish River. From about 15 miles up, to the mouth of the Fish River, the valley narrows and supports a mixed scrub-bush vegetation. Karroid scrub is also developed to a marked degree in certain areas of the Bushmans River valley, particularly in the vicinity of Sandflats and Alicedale, and, to a lesser extent, in parts of most of the other river valleys between the two main rivers mentioned. In the intermediate valleys the percentage of woody forms is greatly increased at the expense of the succulent flora, but the karroid nature is nevertheless made evident by the presence of arborescent species of *Aloe* and *Euphorbia*. Closer examination reveals many dwarf succulents in such areas.

On the higher plains, between the river valleys, grassveld is dominant. The approach to the valleys is often covered by broken veld in which scrub and grassveld are present in approximately equal areas.

North of Grahamstown, about 15 miles from the mouth of the Fish River, the valley broadens out considerably. There is, generally speaking, a gradual rise from the river to the base of the steep marginal hills 10 to 15 miles apart. The main hills are steeply gorged and traversed by numerous watercourses cut by periodic flood waters. In some instances intermediate ridges and koppies rise precipitously out of the plains. Plutos Vale and Hell Poort, names suggesting places of an unenviable reputation, are on the roads from Grahamstown through the Fish River valley to Kingwilliamstown and Bedford respectively. Certainly very hot passes during summer, they are nevertheless the homes of many botanical treasures, particularly succulents.

*Portulacaria* and *Euphorbia* veld : *P. afra* Jacq. and a species of *Euphorbia* (*E. bothac* Lotsy p.h.), 3 to 5 ft. high, are very abundant. The latter is dominant or sub-dominant on the flats over large stretches many square miles in extent, and penetrates the scrub on the open hillside also (Dyer, 1931). *P. afra*, although common on the flats, is particularly abundant on the more wooded slopes, where its dominance is not so evident except when its bright pink flowers give a gl. w to the whole country side. It is occasionally associated with the shrub of similar growth form, *Crassula argentea* Thunb., and frequently with a shrubby sp. of *Euphorbia*, *E. pentagona* Haw.

Associated with the succulent *Euphorbia* on the flats, a few species of shrubs may stand out prominently at certain seasons. Some of the most important among these are *Capparis citrifolia* Lam., *Rhigozum obovatum* Burch., *Brachylaena elliptica* Less., *Schotia speciosa* Linn. and *Pappea capensis* E. & Z.; occasionally one or other may become subdominant over small areas but in general the scrub is very heterogeneous.

In open spaces in this scrub formation, dwarf succulents, including a large percentage of *Mesembryanthemum* spp., are characteristic. There may be present also *Crassula* spp., *Euphorbia inermis* Mill., *E. cumulata* R. A. Dyer, *E. mauritanica* Linn., *Pachypodium succulentum* DC., *P. bispinosum* DC. and *Pelargonium* spp. A number of species of Acanthaceae are found under the protection of larger plants.

Removed from the exposed flats, on the hillsides and in the ravines, the scrub becomes denser. In place of the low shrubby *Euphorbia*, arborescent species become prominent, particularly *E. triangularis* Desf. and *E. tetragona* Haw. Associated with these are arborescent species of *Aloe*, for example *A. speciosa* Baker, *A. pluridens* Haw. and *A. africana* Mill. *Pelargonium peltatum* Ait. and *Sarcostemma viminalis* R. Br. are frequently conspicuous scrambling over shrubs. A diverse dwarf succulent undergrowth is commonly found in the more protected parts and on steep krantzies.

In the northern section of the Fish River valley through Hell Poort, 22 to 27 miles from Grahamstown, known as the Dikkop Flats, karroid scrub gives way to a stretch of typical dwarf Karroo veld. The presence of this formation links the local flora with yet another vegetation type. The species found on the Dikkop Flats are for the most part found also in open spaces between karroid scrub. For this reason the species are dealt with together with those typical of karroid scrub (see later under Section 4, "Power to Survive Desiccation").

In some areas on the north-western boundary adjoining Somerset East, *Pteronia incana* Less. is common and in some parts dominant. Unlike most karroid shrublets it is grazed very little by stock, and in consequence overstocking facilitates its spread. In temporary pools *Rorippa fluviatilis* R. A. Dyer is often conspicuous with its yellow flowers. It may be associated with *Cyperus* sp. and perhaps more surprisingly with *Marsilia macrocarpa* Presl.

Other interesting records in this scrub veld are the cycad, *Encephalartos Lehmannii* Lohm. with sharply lobed leaves, and the ferns (*Pollcia* spp.) found occasionally on rocky outcrops. *Testudinaria elephantipes* Burch. has been recorded but its distribution in this area is evidently very limited.

Introduced *Opuntia* spp. are now abundant in many places, particularly in the vicinity of roads and on krantzies. These have been spread largely by natives, baboons and monkeys that eat the ripe fruits and expel the undamaged

seed. The phylloclades or leaf-like stems of some of the now "wild" forms of *Opuntia* are not very prickly and are eaten directly from the bushes by cattle.

Certain areas, 7 to 10 miles north of Grahamstown, largely denuded by various agencies of its former, probably fairly dense karroid scrub, have been colonised by dwarf Karroo bushes of excellent grazing qualities. This course of succession is interesting, and, although the transformation has taken place within about the past 50 to 75 years, it would no doubt take a very much longer period to effect recolonisation by karroid scrub under natural conditions.

It is, however, obvious that dwarf Karroo types (*Pentzia* spp., etc.), have been interspersed with the scrub in this area for a great length of time, for in addition to the commoner species, there were found in one small patch the following minute rarities, which normally could not become associated in a new habitat in a short space of time: *Eriospermum Dregei* Schonl., *Ornithogalum unifolium* R. A. Dyer, *Drimia* sp. nov. and a form of *Bulbine mesembryanthemoides* Haw.

The ill effects of overstocking are much more persistent in karroid veld than they are in grassveld and bush, for the reason that regeneration under the abnormally severe conditions is very slow. Karroid scrub has a high feeding value and the tendency is to overstock it with Persian sheep and scrub cattle. In many places the more palatable species have become rare, and possibly some even extinct. Goats in quantity are a serious menace to any veld and they have, unfortunately, been herded extensively by natives in parts of the Fish River scrub. Reference has been made previously to the damage done to small succulents by ostriches. An indigenous species of tortoise which occurs in quantity has no doubt been a limiting factor in the distribution of small succulents from time immemorial. An interesting point about the diet of the tortoise is the large amount of *Cotyledon* which it consumes without harm—other animals rarely eat these plants, several species of which have been proved toxic.

Formerly this veld supported a great quantity of large wild animals, whereas comparatively very few remain at the present time. Paterson relates this in his account of his journey, 1776–7, and states that the vegetation was impenetrable except along elephant tracks. Now these tracks have been enlarged and numerous others developed. As mentioned previously an important point with regard to wild animals and the balance of biotic factors is the selective feeding of game, each species showing a preference for certain plants. The different animals are therefore able to live together without severe competition.

Considering the hot dry conditions which prevail throughout most of the year it is surprising that so many herbs and shrubs are capable of surviving. Under average conditions the water lost by transpiration during the day may well be replaced from the soil during the cooler nights. In severe droughts this is definitely not possible and for protracted periods leafy plants are never fully turgid. The old idea that xerophytes, among other special characters for the prevention of excessive transpiration, have very sensitive stomata, has undergone considerable modification within recent years. It is now generally realised that many of the woody plants inhabiting arid regions regularly suffer excessive water loss, and it is their capacity to suffer this loss and wilting, without permanent harm, that enables them to colonise karroid regions (Maximow, 1929, etc.).



Although the formidable appearance of karroid scrub may be accentuated during droughts, when thorns, spines and prickles become more exposed, it has its compensations during good seasons. At these times its beauties surpass those of all other communities. In addition to the pink glow imparted by the flowers of *Portulacaria afra* Jacq., the beautiful yellow bells of *Rhigozum obovatum* Burch. may be seen densely covering many square miles of veld. *Pelargonium peltatum* Ait., scrambling over shrubs, flowers profusely. In the open spaces, often intermingled with shrubs, are numerous species of *Mesembryanthemum* with brightly coloured flowers. Red- and yellow-flowered species of *Cotyledon* abound in certain areas. *Strelitzia Reginae* Banks occurs plentifully in rocky ground leading to Plutos Vale, where its stately yellow and blue flowers are to be seen over a lengthy period each year. Various species of *Aloe* make an excellent show, and of these *A. speciosa* Baker is probably the most handsome. Even species of *Euphorbia*, with relatively inconspicuous individual "flowers," by reason of the cumulative effect of dense yellow inflorescences, give the landscape a pleasing outlook. Many other species might well be mentioned.

In the case of karroid scrub, instead of giving distribution records under family headings, it is considered better to enumerate the species according to their growth-form in relation to the habitat requirements.

The main factors determining evolution in karroid areas :—

A.—Rainfall.

B.—Temperature.

The main evolutionary tendencies of plants in karroid areas (not in order of importance) :—

1. Tolerance of a wide range in temperature.
2. Economy of water :
  - (a) Absence or reduction in size of leaves.
  - (b) Development of thick cuticle and sclerenchyma (and reduction in size of stomata ?).
  - (c) Pubescence.
3. Power to profit by rainfall :
  - (a) Surface moisture.
  - (b) Low water-table.
4. Power to survive desiccation.
5. Viable seeds, annuals.
6. Conservation of water—succulence :
  - (a) Subterranean storage organs.
  - (b) Succulent stems.
  - (c) Succulent leaves.
7. Spinescence.

## THE MAIN FACTORS DETERMINING EVOLUTION.

## A.—Rainfall.

It has been pointed out in the introductory remarks on rainfall that the average in karroid scrub areas varies from 10 to 15 inches per annum, and further, that rains carried from the coast by S.E. winds are partly or completely intercepted by intervening hills before reaching the Fish River valley. On the other hand thunder storms are more frequent along the Fish River valley than they are elsewhere. The rainfall figures in the tables should be consulted. The absolute minimum figures recorded at Rockcliffe (Bushmans River valley) by J. Thomas and at Brandeston by A. T. Rivett Carnac, 4.39 inches and 4.76 inches respectively, are particularly noteworthy. The average rainfall figures are of importance, but the absolute minimum figure gives a truer conception of the importance of rainfall as a limiting factor in the plant distribution.

## B.—Temperature.

Official temperature figures are not available from the hottest valleys, and reliance must be placed to some extent on a few unofficial figures. Whereas the absolute maximum in Grahamstown over a number of years was 108° F., as shown in Table V, temperatures of 112° F. are not uncommon in the Fish River valley, and the annual absolute maximum in this area is about 115 to 120° F. Coupled with high temperatures and low rainfall is a correspondingly low humidity.

In spite of the high maximum temperatures, frosts are not uncommon in winter. An instance has been cited of a difference in temperature during a day of 49° F. Here again it is not the average temperature records which are of importance as limiting factors in plant distribution, but the absolute maximum and absolute minimum temperatures.

## MAIN EVOLUTIONARY TENDENCIES.

1. *Tolerance of a Wide Range in Temperature.*

The various results of evolution for economising and profiting by the meagre rainfall have at the same time largely fortified the vegetation against the effects of high and low temperatures.

2. *Economy of Water.*(a) *Absence of Leaves (excluding Succulents), Deciduous Shrubs.*

If succulents with rudimentary leaves (*Euphorbia* spp.) are excluded, this group is very poorly represented. *Cadaba juncea* Harv. has practically no leaves, *Rhigozum obovatum* Burch., *Acacia Karroo* Hayne and some species of *Asparagus* are deciduous. Many of the xerophytic shrubs shed their leaves to some extent during very dry periods but are not truly deciduous. The leaves of both shrubs and shrublets are generally smaller than those of similar species in moister areas, but reduction in size alone is not always correlated with dry conditions (Thoday, 1931).

(b) *Development of Thick Cuticle and Sclerenchyma (and Reduction in Size of Stomata?).*

No measurements or counts have been made with the specific object of testing these characters and the species listed under this heading are those which have fairly "tough" leaves, judged by the appearance and feel. As stated previously the stunted evergreen elements intermingling with succulents, many of which are spinescent, give karroid scrub its characteristic appearance.

In relatively undisturbed areas it forms an almost impenetrable thicket of a most formidable character. The following are all common or frequent: *Heeria mucronata* Bernh., *Rhus longispina* E. & Z., *R. incisa* var. *obovata* Schönl., *Carissa haematocarpa* DC., *Acokanthera venenata* G. Don., *Ehretia rigida* Druce, *Capparis oleoides* Burch., *C. citrifolia* Lam. with hooked prickles, *Gymnosporia polyacantha* Szysz., *Pteroclastrus tricuspidatus* Sond., *Brachylaena ilicifolia* Phill. & Schw., *B. elliptica* Less., *Royena cordata* E. Mey., *Euclaea undulata* Thunb., *Schotia speciosa* Linn., *S. latifolia* Jacq., *Ptaeroxylon obliquum* Radlk., *Jasminum multipartitum* Hochst., *Scutia myrtina* Kurz, and *Pappea capensis* E. & Z. Others such as *Phyllanthus verrucosus* Thunb., *Croton rivularis* Müll. Arg., *Cissampelos* spp., *Plumbago capensis* Thunb., *Allophylus dcepiens* Radlk., and *Heteromorpha arborescens* Cham. & Sch. are not so obviously tough-leaved and occur sheltered from the most severe environment.

### (c) Pubescence.

Although it has been generally accepted that pubescence is a protection against excessive transpiration, its presence cannot be taken as of fundamental importance. Were this so the percentage of pubescent species would have been increased by the influx of other pubescent species from ordinary scrub and fynbos. On the other hand, plants such as *Lasiocorys capensis* Benth. and *Osteospermum moniliferum* Linn., in colonising areas like Namaqualand, are progressively more densely covered with indumentum as the severity of hot and droughty conditions increases. *Capparis citrifolia* Lam. is both more pubescent and spinescent in the Fish River valley than it is when growing in coastal scrub.

Some of the more conspicuously pubescent plants are: *Lobostemon argenteus*, Buek., *Rhus incisa* var. *obovata* Schönl., *Heeria mucronata* Bernh., *Aster hyssopifolius* Berg., *Pteronia incana* DC., *Brachylaena ilicifolia* Phill. & Schw., *B. elliptica* Less., *Pentzia* spp., *Helichrysum* spp., *Lasiocorys capensis* Benth., *Hermannia* spp., *Lasiophyon Meisnerianus* Endl. As compared with the shrubs with tough leaves, which are mostly glabrous, these pubescent examples are generally smaller and include a number of undershrubs.

Some succulents, such as *Senecio pyramidatus* DC. and *S. scaposus* DC., also have the protection against water loss of a dense indumentum.

## 3. Power to Profit by Rainfall.

### (a) Surface Moisture.

In order to take advantage of light showers, or surface moisture after a storm of short duration, roots must be near the surface of the soil. This surface root system is particularly noticeable in many succulents. Frequently these plants have long roots running slightly below the surface over a very much larger area than the plants cover above ground, and they have little or no development of a deeper root system. *Mesembryanthemum* spp. and *Euphorbia* spp. show this adaptation remarkably well. In some species of *Euphorbia*, however, e.g. *E. squarrosa* Haw., there is developed a large tap-root for moisture and food storage: from this a few secondary roots grow upwards to within a fraction of the soil surface and then run parallel to it for some distance. Since the soil surface is usually porous, these surface roots are in a position to profit by a very small moisture precipitation.

Most woody plants have the surface root system developed to a certain extent, but in the absence of water storage organs, cannot usually rely on this alone.

(b) *Low Water-table.*

It is rarely possible to trace the complete root system of large plants without considerable excavations and a good labour supply; occasionally, however, one has the advantage of road cuttings and quarries. In such places roots of shrubs can be traced at least 12 to 15 feet below the surface and they possibly penetrate much deeper. It may be assumed with a fair measure of certainty, that the xerophytic shrubby species with tough leaves, mentioned previously, generally have deep root systems in addition to surface roots.

4. *Power to Survive Desiccation.*

The power of plants to withstand desiccation is in a measure correlated with a general reduction in size, both in height and leaf surface. Into this class dwarf Karroo shrublets must be placed. Why should these shrublets, with no water storage organs, survive under severe Karroo conditions, not only survive, but also afford some of the best sheep veld in the Union? When soil moisture conditions are favourable, these shrublets transpire remarkably freely. They do not show any unusual power to prevent water loss as the quantity of available soil moisture is reduced. Their root system is no doubt well developed, but the fact remains that even the developing seedlings are able to survive periods of drought and intense heat. After severe droughts the small bushes become dry and brittle and often appear dead, yet, on the advent of good rains, they revive in an astonishingly short period and put forth new growth. The main reason for their vitality appears to be their capacity for enduring very considerable desiccation without suffering permanent injury. Most of the shrubs mentioned in 2 (b) possess this capacity of endurance to a marked degree.

As has been mentioned previously, typical Karroo veld extends into Albany down the Fish River valley over the Dikkop Flats near Carlisle Bridge (or one might suggest a reversion of the direction of colonisation). These shrublets are found throughout karroid scrub veld (where the shrubs are not too tall and dense) usually in association with dwarf succulent shrublets of *Mesembryanthemum* spp., etc. Some of the more common woody examples are: *Pentzia incana* O.K., *P. globosa* Less., *Aster filifolius* Vent., *A. muricatus* Thunb., *A. barbartus* Harv., *Chrysocoma tenuifolia* Berg., *Pteronia incana* DC. (three other species of *Pteronia* are rare), *Pegolettia baccharidifolia* Less., *Helichrysum pentzioides* Less., occasional, *Relbunium genistifolia* L'Herit., *Dimorphotheca Zeyheri* Sond., *Tripteris sinuata* DC., all Compositae, *Hermannia pallens* E. & Z., *H. vernicata* K. Schum., *Pelargonium* sp., *Sutera atropurpurea* Hiern, *S. pinnatifida* O.K., *Aptosimum depressum* Burch., *Lycium* spp., *Tetragonia* spp., *Lasiocorys capensis* Benth., *Becium Burchellianum* N.E. Br., *Walafida geniculata* Rolfe, *Thesium rigidum* Sond., *Polygala leptophylla* Burch., *P. asbestina* Burch., *Indigofera argyrea* E. & Z., *I. patens* E. & Z., *Melolobium candicans* E. & Z., and a few other Leguminosae are rare; *Barleria pungens* L.f. The following shrublets are more under the protection of shrubs: *Hibiscus aridus* R. A. Dyer, *H. calyphyllus* Cav., *Pelargonium multicaule* Jacq., *P. ionidifolium* E. & Z., *Barleria obtusa* Nees, *Blepharis capensis* Pers., *B. sinuata* C.B. Cl., *Justicia protracta* And., *Isoglossa origanoides* Lindau, and a few others.

To survive in this community under the most severe conditions perennial grasses must be capable of withstanding extreme desiccation: even so it is not surprising to find a few species capable of this, e.g. *Aristida congesta* R. & S., *A. barbicollis* Trin. Rupr., *A. vestita* Thunb., *Cynodon incompletus* Nees, *Microchloa caffra* Nees, *Eustachys paspaloïdes* L. & M., and *Ehrharta calycina* Sm. A number of others occur on the border of karroid scrub in the "broken" or

"gebroke veld." It is, however, a most unusual habitat for Cyperaceae and the occasional presence of *Fimbristylis ferruginea* Vahl in open stony ground is noteworthy.

#### 5. Viable Seed: Annuals.

Bews (1925) emphasises the view that annuals represent the most perfect kind of adaptation to dry conditions. Those characteristic of the Karroo germinate rapidly after good rains and complete their life cycle within a relatively short period. The seed is capable of withstanding long periods of drought without losing its viability. This group is not very strongly represented in karroid scrub formation. The following list is a fairly complete record of species: *Cuspidia araneosa* Gaertn. (*Didelta*) is most interesting as it has no means of seed dispersal from the capitulum: the bracts close over the achenes, which, when favourable conditions occur, germinate within the capitulum through which the roots penetrate. Others are: *Oligocarpus calendulaceus* Less., *Ifloga verticillata* Fenzl., *Cineraria platycarpa* DC., *Amellus strigosus* Less., *Tetragona echinata* Ait., *Diascia cuneata* E. Mey., *Lessertia annularis* Burch., *Tribulus terrestris* L., *Papaver aculeastrum* Thunb., *Lepidium africanum* DC. (annual or biennial), *Sisymbrium Burchellii* DC. and a few introductions.

Seed of some perennials is also viable for long periods but little reliable data are yet available. Following good rains, after long periods of drought, seedlings of Karroo bushes such as *Pentzia* spp. may be observed in abundance. *Euphorbia* spp. set seed plentifully but are usually very heavily infested with the larvae of one or more small insects. A similar fate overtakes a large percentage of fruits of other genera.

Monocotyledons are almost unrepresented in this class. The grasses *Chloris virgata* Sw. and *Aristida* spp. occur after rains, *Lepturella capensis* Stapf is rare.

#### 6. Conservation of Water: Succulence.

- (a) *Subterranean Storage Organs* (Tubers, Corms, Rhizomes, Bulbs, thickened Roots, etc.).
- (b) *Succulent Stems.*
- (c) *Succulent Leaves.*

##### *Succulence.*

In view of the importance of succulent plants in karroid scrub formation, the conclusions of Chapman (1931) may be summarised here. He states that the occurrence of succulence is probably due to the greater water-retaining power of the compounds of the monovalent metals with various cell constituents as compared with the retaining power of the compounds of the divalent metals: further, that it is significant that a rise in temperature should cause the compounds of the divalent metals to behave more like the monovalent ones and should also increase the tendency to succulence, and the percentage of monovalent metal required to produce succulence appears to be less for nitrogen-starved plants than for normal plants. Chapman further draws attention to the fact that in deserts and on sand-dunes the nitrogen supply is limited and in all cases the soil contains soluble salts of the monovalent metals sodium and potassium. The high temperature to which most plants in dry areas are subjected must also be considered. A swelling of the cells of the mesophyll is mainly responsible for thickening the leaves. It is true that the pentosan content is raised by nitrogen starvation but Chapman does not consider that it bears any relationship to succulence. Bews and Vanderplank (1930), working on *Portulacaria*

*afra* Jacq., found that pentosan sugars accumulated during dry weather and decreased in percentage on the advent of rains.

(a) *Subterranean Storage Organs include Modified Stems (Rhizomes, Corms, Tubers), Modified Leaf-bases (Bulbs) and "Tuberous" Roots.*

The term tuberous has come to have a wider meaning than formerly and is now applied to modifications of both roots and stems. Corms, bulbs and tubers are almost family characters in the Monocotyledons and the fact that plants with these organs are common in scrub cannot be considered of particular significance. Bulbs, etc., grow normally under diverse climatic conditions, both very wet and very dry. Their main function is to store food and moisture to allow of an annual resting and maturing period preparatory to flowering and the production of new growth largely independent of seasonal rains. The presence in certain groups of plants of these storage organs has facilitated colonisation by them of dry areas, where the stimulus of local conditions has evolved new forms. The enlargement of the root system proper, for food and water storage, is not such a common feature of plants in areas of good rainfall and their development in dry areas may be interpreted in the majority of cases as a direct response to the periodic shortage of water. However, many tuberous-rooted *Asclepiadaceae* are found scattered in grassveld, whereas few species occur in karroid veld. In the latter habitat are found: *Raphionacme Zeyheri* Harv., *Fockea cylindracea* R. A. Dyer (rare), *F. gracilis* R. A. Dyer (rare), *F. edulis* K. Schum., *Ceropegia ampliata* E. Mey. Other Dicotyledons are *Euphorbia squarrosa* Haw., *E. inermis* Mill., *E. Huttonae* N. E. Br., *E. micrantha* Boiss., *E. rhombifolia* Boiss., *E. hastisquama* N. E. Br., *E. tridentata* Lam., *Mesembryanthemum* spp., *Pelargonium* spp., *Pachypodium succulentum* DC. and *P. bispinosum* DC. both with very large storage organs. A number of Leguminosae, both in grassveld and karroid veld, have somewhat tuberous roots, but more often the roots are fairly solid and not fleshy. *Ipomoea argyreoides* Choisy (Figs. 39 and 40) has a large swollen root; *Kelostis Zeyheri* Cogn., *K. digitata* Cogn., *K. glauca* Cogn., *Chamaecapensis* E. & Z., are occasional. *Othonna auriculifolia* Licht., *Senecio othonniformis* Fourcade, *S. crassiusculus* DC., *S. oxyodontus* DC., *Doria carnosus* DC. and *D. criocarpa* DC. give Compositae fair representation.

Among the Monocotyledons *Liliaceae* develop tubers, tuberous roots and bulbs; *Amaryllidaceae*, bulbs and rhizomes; *Iridaceae*, corms and rhizomes.

The genus *Eriospermum* is extremely interesting morphologically. It thrives equally well in areas of high and low rainfall, and it is the tuber storage organ which has enabled the genus to penetrate from grassveld into karroid veld and Karroo areas. During the colonisation of dry areas there has been no special modification of the tuber but leaf modification, due to change of environment, can readily be traced. In grassveld areas leaves are entire and occasionally more than one is produced from each "eye," whereas in many Karroo species the leaves are either reduced in size or very much divided. In *E. Dreyeri* Schönl., which occurs in the broken karroid scrub veld north of Grahamstown, the leaves are not only much dissected but they are also usually densely pubescent. Species showing no special modification, however, occur in the same surroundings.

Species of *Asparagus* associated with bush and forest have tuberous roots and this character has made the evolution of drought-resisting species a simple matter. At least 6 species occur frequently, including *A. multiflorus* Baker, *A. subulatus* Thunb., *A. striatus* Thunb., *A. racemosus* Willd. and *A. Kraussii* Baker. *Chlorophytum* spp., with fleshy roots, occur occasionally in undergrowth. The number of species with bulbs is not much greater than the number

of species in the above-mentioned groups with tubers, etc. Frequent or common examples are: *Ornithogalum thyrsoides* Jacq. in two varieties, *O. flavovirens* Baker, *Drimia anomala* Benth., *Massonia Huttoni* Baker, *Albuca tortuosa* Baker, *A. tenuifolia* Baker, *Albuca* spp. and *Scilla lanceifolia* Baker. *Dioscorea* spp. are rare.

Amaryllidaceae are represented by *Buphane disticha* Herb., *Ammocharis coranica* Herb. (= *A. falcata* Herb.), *Nerine flexuosa* Herb., *Cyrtanthus helictus* Lehm., *Haemanthus albiflos* Jacq.; *Hypoxis* spp. (Hypoxidaceae) are occasional.

Iridaceae are uncommon as regards the number of species but certain species, such as *Moraea polystacha* Ker., are locally abundant, *Dictes* sp. is general.

Orchidaceae are represented by one or two species of *Lissochilus* with rhizomes, and *Strelitzia Reginae* Banks, Musaceae, has thick succulent roots which render it very drought resistant.

### (b) Succulent Stems.

It is not always possible to say with certainty whether a plant should or should not be classified as having a succulent stem. Many species, particularly those with fleshy leaves, have soft juicy young stems which become woody with age, for example *Cotyledon* spp. and *Crassula* spp. *Portulacaria afra* Jacq. is noted as a succulent more for its leaves than its soft fibrous stems. *Crassula argentea* Thunb. and some *Mesembryanthemum* spp. are in the same category. *Pelargonium carnosum* Ait. is half succulent, and *Sarcostemma Vanderietiae* is of a light pithy texture, impregnated with wax. Typical stem-succulents usually have small or rudimentary leaves. These occur commonly in *Euphorbia* and several genera of Asclepiadaceae. In 1931 I went into some detail of the distribution of species of *Euphorbia* in the eastern Cape Province. It was then pointed out that the dwarf shrub (*E. bothae* Lotsoy p.h.) is common or dominant over large stretches in the Fish River valley; associated species are *E. pentagona* Haw., *E. cumulata* R. A. Dyer, occasional, *E. mauritanica* Linn. and *E. inermis* Mill. locally abundant, and two or three other species occasional. The larger tree forms are not found on the open flats but *E. triangularis* Desf. and *E. tetragona* Haw. are common or even dominant on some slopes and koppies; *E. curviraia* R. A. Dyer and *E. grandidens* Haw. are rare, although occasionally locally abundant. *E. polygona* Haw. grows socially on some hillside quartzite outcrops, *E. inconstantia* R. A. Dyer is rare, as also the dwarf species *E. squarrosa* Haw. *E. mammillaris* Linn. is occasionally abundant in undergrowth. *E. valida* N.E. Br. is common on the Dikkop Flats and a few other species occur in the mixed scrub veld. *Jatropha capensis* Sond. is a common half succulent shrub.

Succulent-stemmed Asclepiadaceae are rarely abundant or as conspicuous as the species of *Euphorbia*. They are generally scattered under the shelter of shrubs. *Stapelia flavirostris* N.E. Br. and *S. conformis* N.E. Br. are fairly frequent in parts; the following are rarer: *S. MacOwani* N.E. Br., *Huernia barbata* Haw., *H. Thureti* Cels, *Durvalia reclinata* Haw., *D. modesta* N.E. Br., *Piarranthus foetidus* N.E. Br. and *Ceropegia stapeliiformis* Harv. On the other hand *Sarcostemma viminalis* R. Br. may be conspicuous as a tall climber scrambling over the tops of shrubs. It is less conspicuous as a half shrub. The half shrubby form is very different in habit but shows no tangible floral difference. *Cynanchum sarcostemmatoïdes* K. Schum. is another slender leafless succulent climber.

Compositae, although not specifically common, include examples of this growth form; *Senecio juncus* Harv. on some slopes and koppies and *S. articulatus* (Linn.) Sch. Bip. on flats, are somewhat rare. *Othonna triplinervia* DC. is occasional under protection, *Doria carnosa* DC. and *D. eriocarpa* DC. are rare.

Except where succulent stems are a subsidiary feature to the leaves, such as with *Aloe* spp., etc., the Monocotyledons show no special development towards succulence in the stem.

### (c) Succulent Leaves.

This is the most common form of succulence and examples are found in genera of widely different relationship. As in the case of succulent stems, there are several which may be regarded as transitional forms, and it is a matter of opinion whether they are included or not. Among Dicotyledons, Ficoidaceae and Crassulaceae are particularly advanced in this development; some have succulent stems also, others have slightly hairy leaves. The most prominent and abundant plant is *Portulacaria afra* Jacq. (spekboom) which is subdominant over wide areas. One might refer to it as *Portulacaria* or "spekboom" veld. *Anacampseros arachnoides* Sims and *A. Telephiastrum* DC. are dwarf relatives. The sub-division of the genus *Mesembryanthemum* by several authors into considerably over 100 new genera since 1925 has not yet reached stability and one is diffident at this stage about the application of specific names: the following list of the commoner species, however, will serve to illustrate the richness of the flora in this group of plants: *Mesembryanthemum* (*Ruschia*) *uncinatum* Linn., *M. cymbifolium* Haw., *M. unidens* Haw., *M. Dyeri* N.E. Br., *M. tuberosum* Linn., *Malephora mollis* N.E. Br., *Aridaria Dyeri* L. Bolus, *A.* sp. nov., *Bergeranthus scapiger* N.E. Br., *B. vespertinus* Schwant., *Chasmatophyllum musculinum* Schwant., *Corpuscularia* (*Schonlandia*) *Lehmanni* Schwant., *Delosperma ealycinum* L. Bolus, *D. echinatum* Schwant., *D. laxipetalum* L. Bolus, *D. robustum* L. Bolus, *D. frutescens* L. Bolus (a shrub up to 6 ft. high, rare) and several other species of *Delosperma*. *Drosanthemum cundicans* Schwant., *D. floribundum* Harv., *D. obliquum* Schwant., *Hereroa dolabriformis* L. Bolus, *H. granulata* Schwant., *H.* sp. nov., *Faucaria tigrina* Schwant. (various forms), *Glottiphyllum longum* N.E. Br., *G.* sp., *Lampranthus lepidus* N.E. Br., *L.* sp., *Psilocaulon* spp., *Trichodiadema intonsum* Schwant., *T.* spp., and *T. bulbosum* Schwant.

Among species of *Crassula*, *C. argentea* Thunb. is the most important ecologically, being nearly as common in parts as *Portulacaria afra*, with which it may be readily confused. *C. tetragona* Linn. is also abundant but smaller, and is associated occasionally with the rarer *C. perfoliata* Linn. *C. rupestris* Thunb. and *C. perforata* Thunb. are plentiful on many krantzies; other species present include *C. trachysantha* E. & Z. forma, *C. decidua* Schönl., *C. radicans* Harv., *C. acutifolia* Lam. and *C. lycopodioides* Lam. The allied genus *Cotyledon* is also very prominent with the shrubby forms *C. orbiculata* Linn. and *C. Beckeri* Schönl.; *C. coruscans* Haw., *C. campanulata* Marl., \* *C. gracilis* Harv. and *C. ramosissima* Haw. are also common in parts. In places where two species of *Cotyledon* are found in close proximity, and the flowering period overlaps, evidence of natural hybridisation is usually present. *Kalanchoe rotundifolia* Harv. is frequent in undergrowth.

*Pelargonium carnosum* Ait. is more noted for its succulent stems, but the leaves are somewhat fleshy too; this applies also to the climber *P. peltatum* Ait. which is often found growing in profusion over shrub. A species of *Heliphila* has small but fleshy leaves.

\* *C. campanulata* Marl. ( = *C. teretifolia* Thunb. non Lam.)



Compositae, as would be expected, are not lacking in succulent leaf development and a number of examples are found in *Senecio*. The leaves of *S. pyramidatus* DC. and *S. scaposus* DC. are also covered with a close indumentum. *S. acaulis* Sch. Bip. is rare, whereas *S. radicans* Thunb. is frequent or common. The two similar shrubs *S. longifolius* Linn. and *Euryops tenuissimus* Less., with long slender leaves, are both common on hillsides, although the latter does not penetrate into the very dry areas; *Othonna capensis* Bailey is occasional on krantzes. *Cissus quinata* Ait. has somewhat fleshy leaves. The two parasites *Thesium scandens* E. Mey. and *E. triflorum* Thunb. have juicy leaves, the former being common in restricted areas of this formation, and another parasite *Viscum crassulae* E. & Z. is rare on the branches of *Euphorbia bothae* Lhotsky p.h. and *Protulacaria afra* Jacq.

In considering the Monocotyledons it is necessary to omit from this group of succulents, the Liliaceae and Amaryllidaceae with comparatively large, somewhat fleshy leaves. The fleshy leaf is more or less a family character and not a development in response to dry conditions. *Aloe* spp., *Haworthia* spp. and *Gasteria* spp. are exceptions, since their succulent leaves are usually a definite adaptation to a limited water supply. *Aloe speciosa* Bak. is well named and is a striking feature amongst scrub on hillsides, particularly in Hell Poort and sueh-like places. *A. pluridens* Haw., *A. africana* Mill. and *A. ferox* Mill. are also conspicuous, but do not extend on to the driest flats. *A. microstigma* Salm-Dyck, however, is to be found in thousands on the driest parts of the Dikkop Flats. *A. variegata* Mill. and *A. longistyla* Baker are rare in the same area. *A. tenuior* Haw. in the open broken veld, and *A. ciliaris* Haw. in scrub, require less severe conditions. The polymorphous *A. saponaria* Haw. is rare, while *A. striata* Haw. is common in isolated localities.

Several species of *Haworthia* are present but the soft-leaved ones are usually found under the protection of rock ledges or scrub. Plutos Vale is the home of two rarities, *H. incurvula* and *H. tenera* both described recently by Von Poellnitz. *H. pilifera* Baker, which occurs more in the open, has its soft leaves buried almost entirely below ground level, thus developing the "window-plant" form. *Apicera deltoidea* Baker and *Haworthia* sp., both with hard leaves, occur plentifully in limited areas. Two or three species of *Gasteria* occur frequently throughout this formation.

### 7. Spinescence in Karroid Scrub.

It has been stated that spinescence is one of the main characteristics of karroid scrub. The term spinescence, denoting sharp bodies, has reference to sharp twigs or thorns, peduncular spines, stipular spines, prickles or any other hard pointed part of a plant. In the genus *Euphorbia* some species have stipular spines and others peduncular spines; other genera such as *Asparagus* and *Mesembryanthemum* include species with more than one type of spine. Of the various types of spine, the modified twig and peduncle are no doubt more directly influenced by climatic conditions than the others. Prickles and stipular spines are less influenced by environment and are not so readily explained. Schonland (1927) in a short paper on "Spinosity of Plants" concludes with the following remark: "I hope I have said enough to prove my contention that the question of spinosity is a very complex one." Species of *Euphorbia* with stipular spines are more common in Tropical Africa than they are in South Africa and *E. grandicornis* Goebel, which shows the greatest development of stipular spines in the genus, does not penetrate further south than Zululand. Peduncular spines, on the other hand, are very much more common in arid South Africa than they are in the tropics. It seems, therefore, that the development of

peduncular spines in *Euphorbia* has definitely been stimulated by drier climatic conditions, whereas the stipular spines have not. Another noteworthy point is the fact that species with stipular spines never (at least in the South African species) develop peduncular spines, the peduncles falling after maturity of the fruits. Conversely species with peduncular spines do not possess stipular spines.

It may be significant that of the four local species of *Encephalartos*, *E. Lehmannii* Lehm., which occurs in karroid scrub, has the most rigidly pungent leaves.

The prickles on the leaves of species of *Aloe* have very little real significance as regards habitat. Many of the smaller species in grassveld have small or almost obsolete prickles, whereas others have them prominently developed. The leaves of *A. Marlothii* on koppies in the Transvaal are not only prickly on the margin, but also on the upper and lower surfaces. On the other hand, *A. speciosa*, which occurs abundantly in the karroid scrub of Albany, at Plutos Vale and Hell Poort, is practically unarmed. *A. striata*, which is occasionally associated with *A. speciosa*, is also unarmed. The spines at the base of the leaves of *Phoenix reclinata*, a plant usually associated with an abundant water supply, apparently have no relationship to the environment.

In general it seems justifiable to assume that spinescence, once developed, is an advantage to the species as a means of protection and thus facilitates its increase. Plants not so protected are more readily grazed by stock, and, in times of drought, are apparently more likely to be eaten out than spinescent species. But this view largely ignores the very important subjects of palatability, toxicity, etc. Moreover the spinescent species afford some shelter for unarmed plants. Under natural conditions wild animals migrate to new pastures when grazing becomes scarce, and it seems improbable that unarmed species, once established under normal competitive conditions of evolution, would succumb to grazing by wild animals. It is interference by man, bringing unnatural factors to bear on plant communities, which gives to spinescence undue importance as a force in evolution.

*Thorns*.—In karroid scrub the young growth of *Rhus longispina* E. & Z. may occasionally be entirely leafless and consist of a hard central branch ending in a sharp point with similar lateral twigs. During the second season these thorny twigs produce leaves and inflorescences. *Rhigozum obovatum* Burch., which is particularly abundant in the driest parts of the Fish River valley has mostly thorny twigs. *Cadaba juncea* Harv. has quill-like, practically leafless branches.

The peduncular spines of species of *Euphorbia* are evidently a product of fairly recent evolution and the number of examples increases greatly in karroid and Karroo areas. One of the important ancestral forms is *E. pulvinata*, which has migrated along the mountainous areas from the north-east into the Karroo. This species, however, does not occur locally. Local examples of this type are *E. mammillaris* Linn., *E. cumulata* R. A. Dyer, *E. polygona* Haw., *E. inconstantia* R. A. Dyer and *E. pentagona* Haw. Fertile peduncles generally fall off, or if persistent are not so sharply pointed as when sterile. *E. polygona* may be almost spineless in some places, whereas in others, often drier and hotter (e.g. Hell Poort), spinescence is more marked. *E. valida* N.E. Br., and generally also *E. meloformis*, have persistent peduncles which become hard and sub-spinescent with age. Of these two species, *E. valida*, from the drier and hotter area (Dikkop Flats), is larger and has more robust peduncles.

Species of *Mesembryanthemum* belong to this and the stipular spine group.

The Flacourtiaceae are somewhat of a parallel case to the Celastraceae in that the spinescent species of *Scolopia* and *Dovyalis* occur plentifully in ordinary scrub but hardly penetrate typical karroid scrub. This is noteworthy.

Leguminosae are poorly represented by *Melolobium candicans* E. Mey. and *Indigofera patens* E. & Z. Compositae, the most advanced family in evolution, and represented by far the largest number of species in any one family in this area, has no thorny species in local karroid scrub. This also is noteworthy.

*Thecium rigidum* Sond. is somewhat rare. Several species of *Lycium* are found, generally in dense clumps on termite or rodent heaps.

Among the Monocotyledons, species of *Asparagus* frequently develop thorns and in addition possess stipular spines.

There seems ample evidence, that, in certain species with the potentiality for thorny spinescence, this is stimulated by habitat conditions: the hotter and drier it is, the greater the development of thorns. But it is not universally so, and it is not generally correlated with advanced floral characters.

*Stipular Spines, Prickles, etc. (excluding Thorns).*—In addition to their succulent branches and rootstock, the two species of *Pachypodium*, *P. bispinosum* DC. and *P. succulentum* DC. are spinescent. *Carissa haematocarpa* DC. which also belongs to Apocynaceae, is an armed shrub. Its near ally *C. bispinosa* Desf. (considered as the same species in Fl. Cap.) does not penetrate into typical karroid scrub. *Capparis citrifolia* Lam. is more prickly and pubescent in this community than it is in coastal scrub, but there is no constant distinction between the two forms. *C. oleoides* Burch., which also occurs in both habitats, is always unarmed although it becomes very twiggy under dry conditions.

It has been pointed out that species of *Euphorbia* with penduncular spines, and others with stipular spines, are characteristic of karroid scrub. Those with stipular spines are more abundant in Karroo veld both in the number of species and in the number of individuals. In this connection, however, it must not be lost sight of that the group with stipular spines is far more strongly represented in Tropical and Subtropical Africa. It will be noted further that the large tree forms (comparatively primitive in evolution) all belong to the group with stipular spines (i.e. excluding the unarmed tree *E. Tirucalli* Linn.). *E. triangularis* Desf., *E. tetragona* Haw., *E. grandidens* Haw. and *E. curvira* R. A. Dyer occur plentifully in parts of wooded slopes; of these species the two first-named are the more common and widely distributed. *E. grandidens* is probably the tallest and attains a height of about 50 ft. *E. bothae* Lotz p.h. is much smaller and includes forms nearly identical with *E. Ledenii* Berger and *E. Franckiana* Berger. There are also dwarf species with tuberous roots, e.g. *E. squarrosa* Haw. and *E. micracantha* Boiss.

A few species of *Mesembryanthemum* belong to this group, as also *Sarcocaulon Vanderietiae* L. Bolus.

Leguminosae are represented by *Acacia Karroo* Hayne along dry water-courses, where the spines are occasionally 4 to 6 inches long, and by *A. caffra* Willd., which occurs mostly along the banks of the Fish River, has numerous prickles. *Scutia myrtina* Kurz, Rhamnaceae, does not penetrate much into very dry areas but occurs frequently in scrub. *Azima tetracantha* Lam. is common. As mentioned previously species of *Asparagus* in karroid scrub usually

possess stipular spines and the leaves of most species of *Aloe* are prickly, except in the case of the leaves of *A. speciosa* and *A. striata*.

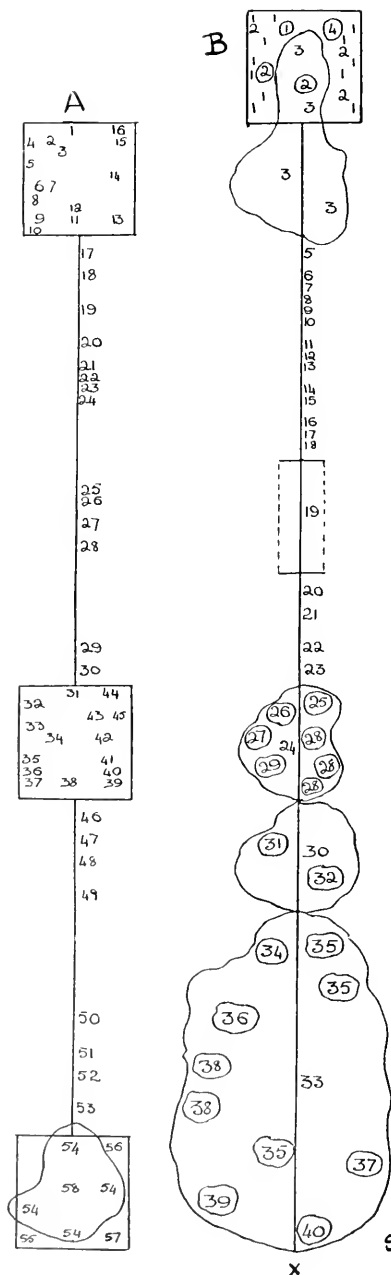
In conclusion it may be stated that, in a study of spinescence in relationship to habitat, greater importance than appears to have been done by many authors, should be given to the morphological character of spines.

## A NOTE ON THE KARROO VELD OF THE DIKKOP FLATS.

Brief reference was made to this area in the general remarks on karroid scrub. On the Dikkop Flats there is a climax community of dwarf Karroo bushes about 6 ins. to 1½ ft. high. It is the S.E. extremity of typical Karroo veld. As the surrounding hills are approached, there is a transitional area between Karroo veld and karroid scrub. It was my intention to carry out observations on permanent quadrats and line transects in this area but my temporary transfer to Kew at the end of 1930 prevented the fulfilment of these projects.

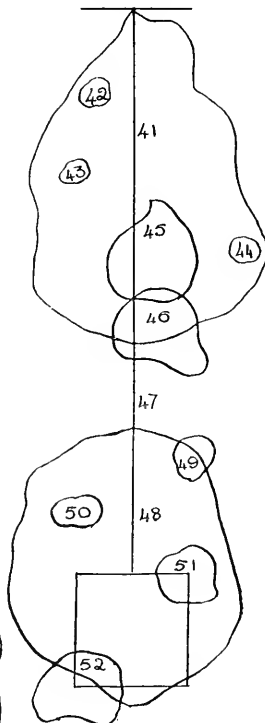
The initial stage has its interest although no conclusions of moment can be drawn.

Diagrams "A" and "B" combine quadrats and line transects and in "B" the belt transect method was made use of to a certain extent. Transect "A" was charted during October, 1929, and represents an average strip of veld on the open flats; list No. I, for chart "A" gives the identifications of the plants as far as it was possible at the time, and a general view of the veld may be seen in Fig. 32. Transect "B" was charted on the same day in the transitional area between the Karroo veld of the flats and the karroid scrub of the hill slopes (Fig. 33). As compared with "A" the number of individuals on the first few yards is greater in "B" (19 : 16 on the first quadrat) but as the size of the individuals increases in "B" (approximate areas covered by individuals indicated for 24, 30, 33, 41, 48, etc.) the relative number of plants per area greatly decreases. A minute study of the undergrowth may well have revealed unrecorded specimens including some geophytes. The plants identified for chart "B" are in list II.



Dikkop Flats -  
Transition from Karrooveld  
to Karroid Scrub.

**B** x  
Animal  
Track



Scale - 1/2 inch = 1 yd. in A & B.

x

## LIST I, FOR CHART A.

- 
1. *Euphorbia valida* N.E. Br.
  2. *Glottiphyllum grandiflorum* N.E. Br.
  3. *Aster filifolius* Vent.
  4. *Euphorbia valida* N.E. Br.
  5. Grass.
  6. *Euphorbia valida* N.E. Br.
  7. Grass = 5.
  8. *Mesembryanthemum* sp. aff. *M. spinosum* Linn.
  9. Grass = 5.
  - 10, 11. *Aster filifolius* Vent.
  12. *Helichrysum pentzioides* Less.
  13. *Glottiphyllum grandiflorum* N.E. Br.
  14. *Tetragona fruticosa* Linn.
  15. *Euphorbia Gorgonis* Berger
  16. *Drosanthemum obliquum* Schwant.
  17. *Hermannia pallens* E. & Z.
  18. *Fockea gracilis* R. A. Dyer
  19. *Chasmatophyllum masculinum* Schwant.
  20. *Chrysocoma tenuifolia* Berg.
  21. *Thesium rigidum* Sond.
  22. *Lepidium africanum* DC.
  23. *Asparagus capensis* Linn.
  24. Grass.
  25. *Lepidium africanum* DC.
  26. *Drosanthemum obliquum* Schwant.
  27. *Crassula* sp.
  28. *Aster muricatus* Less.
  29. *Aster muricatus* Less.
  30. Grass.
  31. *Hermannia pallens* E. & Z.
  32. *Helichrysum pentzioides* Less.
  33. *Thesium rigidum* Sond.
  34. *Aster filifolius* Vent.
  35. *Dimorphotheca Zeyheri* Sond.
  36. *Chrysocoma tenuifolia* Berg.
  37. *Dimorphotheca Zeyheri* Sond.
  38. *Hermannia pallens* E. & Z.
  - 39, 40. *Aster muricatus* Less.
  41. *Mesembryanthemum* sp. aff. *M. spinosum* Linn.
  42. *Tetragona fruticosa* Linn.
  43. *Euphorbia valida* N.E. Br.
  44. *Mesembryanthemum* sp. aff. *M. spinosum* Linn.
  45. *Hermannia pallens* E. & Z.
  46. *Aster muricatus* Less.
  - 47-50. *Mesembryanthemum* sp. aff. *M. spinosum* Linn.
  51. *Aloe longistylis* Baker
  52. *Hermannia flammea* Jacq.
  53. *Aloe tenuior* Haw.
  54. *Pentzia incana* O.K. (in clan formation as indicated).
  - 55, 56. *Mesembryanthemum* sp. aff. *M. spinosum* Linn.
  57. *Aster filifolius* ? dead.
  58. *Drimys anomala* Benth.

## LIST II, FOR CHART B.

- 
1. *Pentzia virgata* O.K. (12 plants).
  2. *Mesembryanthemum uncinatum* Linn. (large clump).
  3. *Tetragona* sp. ? (5 seedlings).
  4. *Euphorbia mauritanica* Linn.
  - 5-9. *Pentzia virgata* O.K.
  10. *Tetragona* sp. ? = 3.
  11. *Psilocaulon simile* N.E. Br.
  12. *Pentzia incana* O.K.
  - 13-15. *Tetragona* sp. ? = 3.
  16. *Pentzia incana* O.K.
  17. *Psilocaulon simile* N.E. Br.
  18. *Pentzia incana* O.K.
  19. *Tetragona* sp. ? large number of seedlings.
  20. *Asparagus capensis* Linn.
  21. *Psilocaulon simile* N.E. Br.
  - 22, 23. *Pentzia incana* O.K.
  24. *Euphorbia* sp. aff. *E. Ledienii* (= *E. bothae* Lotsy in part).
  25. *Cotyledon* sp. nr. *C. gracilis* Harv.
  26. *Hibiscus aridus* R. A. Dyer
  27. *Delosperma calycinum* L. Bolus
  28. Grass.
  29. *Lycium* sp.
  30. *Pappea capensis* E. & Z.
  31. *Delosperma calycinum* L. Bolus
  32. *Cissus quinata* Ait.
  33. *Euphorbia* sp. = 24.
  34. *Asparagus* sp. climber.
  35. Grass.
  36. *Delosperma calycinum* L. Bolus
  37. *Cotyledon* sp. aff. *C. gracilis* Harv.
  38. *Aizoon* sp.
  39. *Crassula Rogersii* Schonl.
  40. *Pentzia incana* O.K.
  41. *Euphorbia* sp. = 24.
  42. *Delosperma calycinum* L. Bolus
  43. *Bulbine caulescens* Linn.
  44. *Kalanchoe rotundifolia* Haw.
  45. *Rhigozum obovatum* Burch.
  46. *Mesembryanthemum tuberosum* Linn.
  47. *Lycium* sp.
  48. *Portulacaria afra* Jacq.
  49. *Asparagus capensis* Linn.
  50. *Lycium* sp.
  51. *Gymnosporia huxifolia* Szysz. ?
  52. *Rhigozum obovatum* Burch.

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## Chapter 8.

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GRASSVELD.

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## CHAPTER 8.

## GRASSLAND OR VELD.

The grasses are of world-wide economic importance and their particular importance to agriculture in the Union of South Africa has been emphasised consistently during recent years. The foresight and energy of Dr. I. B. Pole Evans, Chief, Division of Plant Industry, in initiating a comprehensive scheme for the investigation of promising indigenous grasses has been largely responsible for progress in our knowledge of the grazing qualities of various species and strains, particularly of the "woolly finger grass" type (*Digitaria* spp.). Rapid expansion of the work is taking place at the present time and in this connection grass-breeding with local strains is being carried out in Grahamstown by Mr. C. D. B. Liebenberg.

Grassveld in Albany and Bathurst occupies most of the undulating country between the river valleys from the landward margin of the coastal scrub extending inland up the open slopes and along the summit of the Zuurberg and Zwartwaterberg. There is, however, a considerable amount of broken grassveld in which scrub patches are prominent, and particularly is this the case where *Acacia Karroo* Hayne has been allowed to spread. *A. Karroo* is a pioneer which prepares the way for scrub types, and, if unchecked, is liable to become a pest. North of the Zwartwaterberg grassveld is largely replaced by mixed scrub and karroid scrub except on the intervening parallel ridges between it and the Fish River Rand. The Fish River Rand is a small plateau between the Fish River and its tributary the Koonap River and is covered by good grassveld with a high percentage of "rooigras," *Themeda triandra* Forsk.

The grassveld of this area is to a very large extent what is commonly known as "sour." Due to the low mineral and protein content, it affords relatively poor grazing, the phosphorus and nitrogen deficiency being particularly marked. This deficiency, however, is not so evident in mixed or broken veld where scrub-bush counterbalances, in a certain measure, the mineral deficiency of the grasses. Grasses on the Zuurberg and Zwartwaterberg have an additional disadvantage as regards feeding value and palatability, in that they have an unusually high silica content. The foregoing facts do not imply that good grassveld is entirely absent. In restricted areas, with better soil and an average rainfall of 17 to 25 inches per annum, *Themeda triandra* Forsk. "rooigras" does remarkably well. This applies also to strains of *Digitaria eriantha* var. *stolonifera* "woolly finger grass" which are frequent in the valleys. What was formerly excellent "rooigras" veld in Bathurst is now largely used for the cultivation of pineapples.

Unlike most of the other vegetation types discussed, dominance is very evident in some areas of grassveld. This, as already indicated, refers particularly to "rooigras" and "woolly finger grass" both of which form almost pure stands; the latter, however, to a much more limited extent than the former. *Digitaria eriantha* Steud. (non-stoloniferous) is also dominant in parts. The area occupied by the tall, coarse-growing species of *Heteropogon*, *Cymbopogon*, *Hyparrhenia*, etc., is comparatively small and mostly restricted to the margin of forest. The total number of species of grass is about 125. Partly owing to the dominance

or sub-dominance of certain species over comparatively wide areas this number is far less than the number of associated plants which are scattered throughout.

Various grasses have been referred to previously in connection with their relationship to other communities and the following list and notes summarise the value and frequency of the more important open grassveld species, with occasional references to the economic importance of others.

*Elionurus argenteus* Nees is frequent but of little grazing value; *Cymbopogon prolixus* Phill. and *Hyparrhenia hirta* Stapf, coarse, frequent near bush; *Themeda triandra* Forsk. ("rooigras") often dominant, affords good grazing; *Paspalum scrobiculatum* Linn., *P. distichum* Linn. and *P. dilatatum* Poir., all now cosmopolitan; *Digitaria eriantha* Steud. occurs in numerous varietal forms, some of which are promising for breeding work; *D. littoralis* Stent is one of the segregate species; *Brachiaria serrata* Stapf, *B. arrecta* Stent and *Echinochloa Crus-Galli* Beauv. are of little importance.

*Panicum maximum* Jacq., *P. deustum* Thunb. and *P. perlarum* Stapf are good fodder grasses and occur frequently, occasionally being dominant in and near woods. *Alloteropsis semialata* Hitch. is of little value; *Setaria* spp. are occasional throughout and a strain of *S. perennis* Hack. is giving promising results under cultivation in Grahamstown. *Stenotaphrum secundatum* O. Kuntze is found near streams inland and on river banks near the coast and affords useful grazing besides being a good sand-binder. *Rhynchelytrum setifolium* Chiov. and *R. repens* Hubb. are frequent although of little value.

*Tristachya hispida* K. Schum. (*T. leucothrix*), a common grass about which very divergent views are held as to its feeding qualities, some very favourable, others indifferent. *Pentstemon* (10 spp.) occasional throughout, of little feeding value; *Coeleria cristata* Pers. frequent, of moderate feeding value; *Arenastrum antarcticum* Stapf and *Danthonia* spp. mostly of little feeding value. *Agrostis Bergiana* Trin., rare; *A. lachnantha* Nees, occasional throughout, useful in winter.

Four species of *Aristida*, "steekgras," *A. congesta* R. & S., *A. barbicollis* Trin., *A. capensis* Thunb. var., and *A. vestita* Thunb. are general throughout but rarely dominant. They are pests due to their sharply pointed seeds, which penetrate the hides of sheep, a character shared by *Stipa Dregeana* Steud. *Sporobolus* spp., including *S. capensis* Kunth (= *S. indicus* of Fl. Cap.) are frequent throughout and are of moderate grazing quality when young; *Diplachne fusca* Beauv. is occasional.

Species of *Eragrostis*, particularly *E. curvula* Nees and *E. brizoides* Nees, are common and of fair grazing value when young and in flower; other species are *E. plana* Nees, *E. chalcantha* Trin., *E. obtusa* Munro and *E. gummiflua* Nees. *Cynodon Dactylon* Pers., which is often used as a lawn grass, also affords useful grazing near homesteads and kraals, but produces prussic acid on wilting, in which state it is a menace to sheep: *C. incompletus* Nees is occasional in dry areas. *Microchloa caffra* Nees is a small plant frequent in karroid veld; *Harpachloa Falx* O.K., frequent, coarse; *Eustachys paspaloides* L. & M., general, frequent, often in karroid veld.

*Ehrharta erecta* Lam. and *E. calycina* Sm., both frequent, the former in shady places, the latter in karroid veld, produce prussic acid on wilting. *Lasiachloa longifolia* Kunth is occasional or frequent, *Poa binata* Nees general, and *Festuca* spp. occasional. *Bromus unioloides* H.B.K. is frequent in or near cultivation and makes good winter feed; *B. patulus* Mert. & Koch is less useful; *Lolium* spp. are found near cultivated lands.

*Ehrharta gigantea* Thunb. and *Sporobolus pungens* Kunth are excellent sand binders along the coast. *Spartina stricta* Roth. is especially useful as a fixer of submerged mudbanks in river estuaries.

#### ASSOCIATED PLANTS OF GRASSVELD.

The number of species, other than grasses, is comparatively large, yet individual plants of a species may be few and far between; on the other hand local abundance of certain species is not uncommon. For the most part this flora is comprised of perennials, the majority of which have some means of water and food storage. Monocotyledonous geophytes, with bulbs, corms, tubers, rhizomes, etc., may be abundantly evident for short periods; generally speaking, they develop during early spring and complete their flowering and fruiting cycle within a few weeks, not necessarily dependent on spring rains, but more stimulated by grass fires.

Many Dicotyledons with perennial woody rootstocks are also readily stimulated to rapid growth in early spring, whereas others, with tuberous rootstocks, of which the Asclepiadaceae are noteworthy, develop later in the summer.

Under certain circumstances, however, weather conditions, particularly rainfall, have a marked effect on the time, frequency and abundance of flowering. In the areas of generally low rainfall, i.e. in the Fish River valley, etc., some Monocotyledons may flower profusely one season (often a year following a season of good rainfall) and then for a period of years the same bulbs will flower only sparingly. High temperatures usually accelerate growth, shorten the flowering period and, if very severe, may inhibit seed formation. Annual grass burning is not practised to any extent in this area, and is, therefore, a factor of varying importance as regards its influence on plant succession and the flowering period.

The following list of plants, with occasional ecological notes, will give a general idea of the variety and character of the commoner associated plants in grassveld.

#### *Monocotyledons.*

Iridaceae: *Watsonia Meriana* Mill. and *Dierama pendulum* Baker were formerly abundant on mountain slopes but are now scarcer due to grass fires and sheep grazing; *Watsonia angusta* Ker and *Dierama pansum* N.E. Br. are their counterparts, though rarer, in the low-lying, damp veld towards the coast. *Tritonia lineata* Ker, *Antholyza aethiopica* Linn., *Aristea* spp., *Romulea rosea* Eckl., *Moraea polystachya* Ker, *M. setacea* Ker and *Gladiolus tristis* Linn. are common or occasional generally; *Antholyza caffra* Ker, *Gladiolus permealibis* De la Roche and *Moraea spathacea* Ker are more in the mountain grassveld, and *Freesia corymbosa* N.E. Br. is abundant in dry grassveld north of Grahams-town. *Bobartia spathacea* Ker and *B. Burchellii* Baker are abundant, particularly so in stony, over-grazed areas, where they soon become sub-dominant, their yellow flowers making a "splash" of colour about midsummer.

Species of *Hypoxis* (Hypoxidaceae) are frequent and flower almost throughout the summer. Amaryllidaceae: *Buphane disticha* Herb. is general, *Brunsvigia minor* Lindl. locally common in dry veld; *Cyrtanthus obliquus* Ait. is conspicuous but not plentiful, whereas the small *C. uniflorus* Gawl. may be abundant over wide areas for a few days only in the New Year; *C. angustifolius* Ait. is occasional. Liliaceae: *Gasteria Beekeri* Schönl. occurs plentifully in certain open stony flats towards the coast. *Bulbine asphodeloides* R. & S.

common, *B. longiscapa* Willd. occasional; *Eriospermum* spp. often locally common; *Anthericum* spp. and *Tulbaghia* spp. general; *Drimys haworthioides* Baker, *D. anomala* Benth., *Dipadi ciliare* Baker, *D. viride* Moench, *Albuca* spp., *Scilla* spp., *Ornithogalum thyrsoides* Jacq., *Ornithogalum* spp., *Androcymbium longipes* Baker and *A. melanthoides* Willd. are all frequent or common. The tall "slangkop," *Urginea altissima* Baker is locally abundant in "broken" veld, i.e. mixed grass and scrub veld.

*Dicotyledons* (families mostly in alphabetical order).

Acanthaceae are not common, *Thunbergia capensis* Retz., *T. Dregeana* Nees, *Crabbea nana* Nees and a few others occur occasionally. Anacardiaceae: *Rhus Eckloniana* Sond., a shrub, one of the smallest species in the genus, is rare on rocky slopes, and the shrub or small tree, *Cussonia paniculata* E. & Z., Araliaceae, is also found in similar situations, where grass may not be truly dominant. Asclepiadaceae, the majority of which have some form of tuberous rootstock, are particularly well represented, the more frequent include: *Xysmalobium involucratum* Decne, *Woodia mucronata* N.E. Br., *Schizoglossum cordifolium* E. Mey., *S. tenellum* Druce, *S. heterophyllum* Schlechter and about six other species of this genus, *Asclepias albens* Schlechter, *A. crispa* Berg. var. *pseudocrispa* N.E. Br., and others, *Pachycarpus dealbatus* E. Mey., *P. grandiflorus* E. Mey., *Sisyrinchium* spp., *Anisotoma mollis* Schlechter, *Tenaris rubella* E. Mey. and *Brachystelma* spp. Campanulaceae are also numerous and conspicuous when in flower but rarely dominant; as a general rule they favour moist temperate habitats and for this reason are frequently met with in grassveld in the vicinity of woods: *Parastranthus thermalis* Sond., *Grammatotheca erinoides* Sond., *Dobrowskyia* spp., *Wahlenbergia androsacea* A.DC., *W. undulata* A.DC., *W. capillacea* A.DC. and others, *Lobelia tomentosa* L.f., *L. hirsuta* Linn., *L. Erinus* Linn., and *L. anceps* Thunb. are all either frequent or common. Caryophyllaceae: *Dianthus crenatus* Thunb., *Silene undulata* Ait. and *S. Burchellii* Ott. are also often conspicuous.

Compositae are abundant throughout and the commoner species only are listed: *Vernonia capensis* Druce, *V. Dregeana* Sch. Bip., *V. Bakerianus* Burt Davy, *Pulicaria seabra* Druce, *Oedera imbricata* Lam., *Athanasia* spp., *Eriocephalus umbellulatus* Cass., *Elytropappus Rhinocerotis* Less., a pest in parts, *Gnaphalium* spp., *Leontonyx* spp.; *Helichrysum squamosum* Thunb., *H. appendiculatum* Less., *H. xerophyllum* DC., *H. latifolium* Less., forms of *H. undatum* Less., *H. subglomeratum* Less., *H. anomalum* Less., *H. cymosum* Less., *H. ericifolium* Less., and others; *Disparago ericoides* Gaertn., *Osteospermum imbricatum* Linn., *Cotula* spp., *Senecio speciosus* Willd., *S. crubescens* Ait., *S. glutinosus* Thunb., *S. albanensis* DC., *S. othonniflorus* DC., *S. retrorsus* DC., *Haplocarpha seaposa* Harv., *H. lyrata* Harv., *Arctotis petiolata* Thunb., *Venidium* spp., *Gazania* spp., *Berkheya* spp., *Gerbera* spp. and others.

Convolvulaceae: *Ipomoea simplex* Thunb., *I. crispa* Hallier f. and *I. crassipes* Hook. are runners with conspicuous flowers; *Convolvulus hastatus* Thunb. and *C. calycinus* E. Mey. also occur. Crassulaceae: A few species of *Crassula* may be found and these generally favour rocky slopes where little grass extends, e.g. *C. falcata* Wendl., *C. ericoides* Haw., *C. turrata* Thunb., *C. albanensis* Schonl., *C. trachysantha* E. & Z., *C. vaginata* E. & Z. on grassy hills, and *C. Southii* Schonl. locally abundant in flat sandy areas. Cucurbitaceae: *Coccinia quinqueloba* Cogn. and *Melothria punctata* Cogn. are frequent. Dip-sacaeae: *Scabiosa anthemifolia* E. & Z., *S. Buckiana* E. & Z., and *S. allanensis* R. A. Dyer are conspicuous when in flower and common in parts, *Cephalaria* spp. less so.

Euphorbiaceae are somewhat poorly represented by *Cluytia heterophylla* Thunb., *Acalypha peduncularis* E. Mey., *Adenocline bupleuroides* Prain, *Euphorbia striata* Thunb., *E. elliptica* Thunb., *E. bupleurifolia* Jacq., *E. gorgonis* Berger and others. Ericaceae: *Erica cecinthoides* Linn. and *E. glumifera* Klotz are frequent and widely spread on some mountain slopes, other species may invade grassveld in temperate situations as forerunners of fynbos. Ficoidaceae: A few species of *Mesembryanthemum* are scattered throughout. Gentianaceae: *Sebaea* spp. and *Chironia* spp. are occasional throughout and often common in patches. Geraniaceae are represented by *Geranium incanum* Burm. f., *G. caffrum* E. & Z. and *G. ornithopodium* E. & Z. which are all frequent; *Monsonia ovata* Cav. common, *Pelargonium reniforme* Curt., *P. sidifolium* Knuth, *P. capitatum* Ait., *P. alchemilloides* Willd. and others are occasional. Hypericaceae: *Hypericum athiopicum* Thunb. and *H. Lalandii* Choisy are both frequent.

Labiatae have the widespread *Teucrium africanum* Thunb., *T. capense* Thunb. and *Ajuga ophrydis* Burch., and occasional plants of *Stachys* spp. and *Leonotis* spp. Leguminosae are strongly represented nearly throughout. The commoner species are *Amphithalea phyllicoides* E. & Z., *A. Williamsoni* Harv., *Crotalaria* spp. (3), *Lotononis Woodii* Bolus, *Argyrolobium* spp. (8-9), *Medicago Aschersoniana* Urban, *Indigofera* spp. (10), *Tephrosia* spp. (3), *Lessertia* spp. (3), *Zornia tetraphylla* Mich., *Vigna* spp. (3), *Dolichos* spp. (3), *Rhynchosia* spp. (3), *Eriosema* spp. (2), *Cassia mimosoides* Linn. and others.

Malvaceae: *Hibiscus athiopicus* Linn. is frequent and *H. pusillus* Thunb. occasional. Oxalidaceae: About 9 species of *Oxalis* are scattered throughout. Polygalaceae are comparatively well represented by *Polygala ericifolia* DC., *P. refracta* Burch., *P. hispida* Burch., *Muraltia alopecuroides* DC., *M. squarrosa* DC. and *M. ericifolia* DC., those of the latter genus having a strong affinity with the south-western flora. Ranunculaceae: *Ranunculus pubescens* Thunb. is found in damp depressions, *Anemone caffra* Harv. and *Knowltonia vesicatoria* Sims in temperate situations, as also *Alchemilla capensis* Thunb., *A. elongata* E. & Z. and *Geum capense* Thunb. Rubiaceae are represented by the widely distributed *Oldenlandia amatimbica* K. Schum. and *Pentanisia prunelloides* Walp. (*P. variabilis* Harv.) and *Anthospermum* sp. Santalaceae: There are six parasitic species of *Thesium*, some of which are common. Selaginaceae are very occasional except for *Selago corymbosa* Linn. which becomes a pest under certain conditions of veld management (not necessarily bad, Dyer, 1932). Scrophulariaceae are mainly from the genera *Sutera*, *Phyllopodium*, *Nemesia*, *Zaluzianskya* and in addition a few parasites. *Phyllopodium cuneifolium* Benth., an annual, occasionally germinates in great abundance near the coast and on inland sandy flats, where it dominates the view when in flower.

Sterculiaceae: A few species of *Hermannia* are scattered throughout the lower altitudes, others are more characteristic of short vegetation fringing bush, as also some Thymelaeaceae: *Struthiola* spp. and *Gnidia* spp. *Lasiosiphon anthylloides* Meisn., *L. capitatus* Burt Davy and *Gnidia* spp. are scattered throughout.

Umbelliferae are rarely found in abundance and are fairly widely scattered in widely different habitats. The more important in grassveld are: *Hydrocotyle verticillata* Thunb., *H. asiatica* Linn., and *H. eriantha* var. in damp places; *H. virgata* L.f., and *Alepidea capensis* (Berg.) R. A. Dyer on temperate hillsides; *Pituranthos aphylla* Benth. and Hook.f. and *Chamarca capensis* E. & Z. in dry veld, and others, including *Rhyticarpus* spp. and *Peucedanum* spp. border on fynbos and bush. *Arctopus echinatus* L., a stemless plant, with a tuberous root and spreading prickly leaves, is a unique associate in temperate grassveld.



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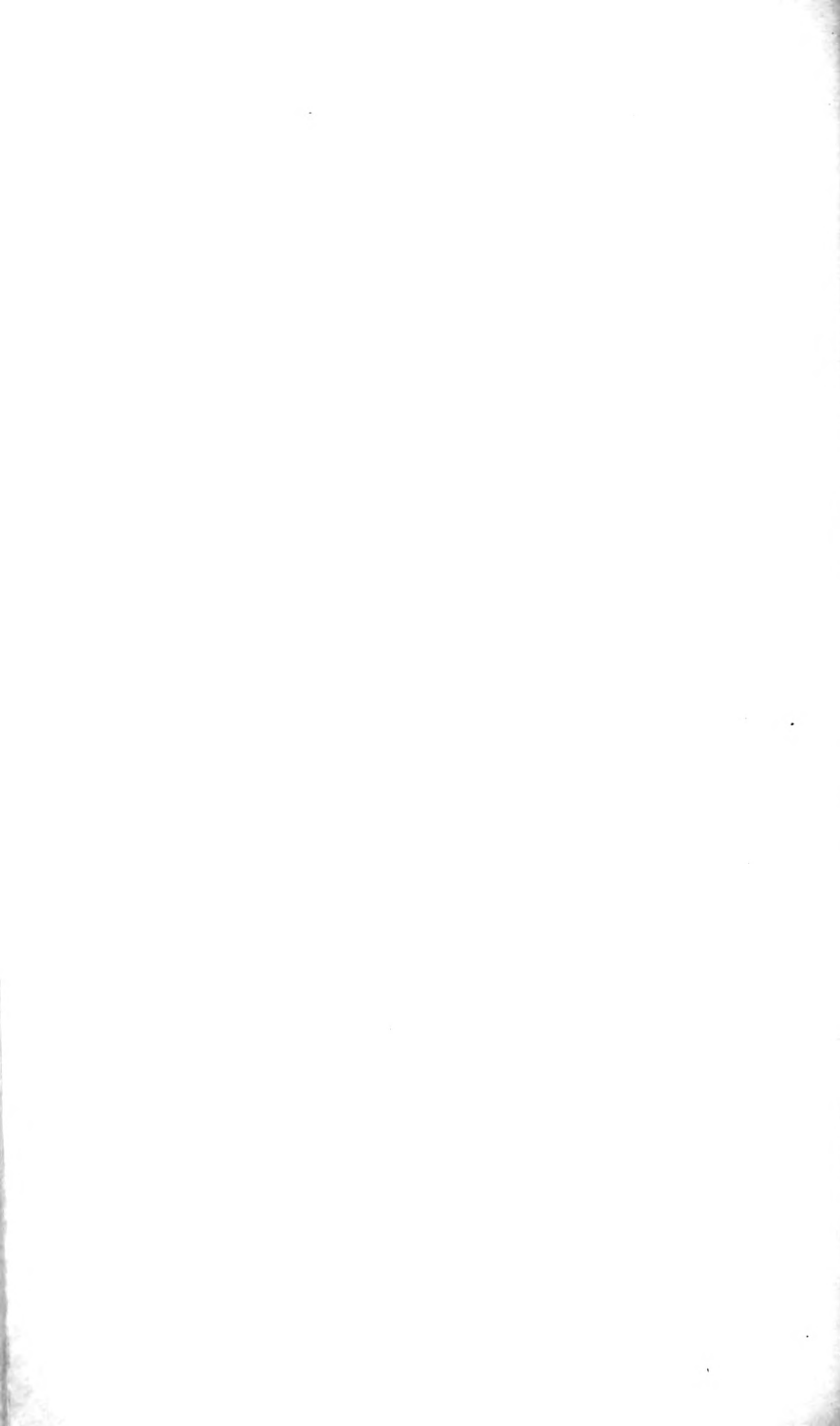
## **Chapter 9.**

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**FLORISTIC DATA AND SOME DISTRIBUTION RECORDS OF  
INTEREST.**

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## CHAPTER 9.

## FLORISTIC DATA AND SOME DISTRIBUTION RECORDS OF INTEREST.

With regard to the subject of the relationship of plants to their environment, *Oldenburgia arbuscula* Less. is an interesting case. This remarkable shrub of Compositae is found only on the Witteberg quartzite outcrops and especially on or above the most rocky bands. This is evident both on horizontal outcrops and on more or less vertical outcrops due to folding (Fig. 15). Although *O. arbuscula* is frequently associated with bush or fynbos it frequently occurs independently of these formations in exposed but temperate positions. A definite reason for its peculiar distribution has not been proved but it seems likely that the water supply is an important factor. *O. arbuscula* does not occur on quartzite outcrops in dryish areas, but in spite of the fact that its habitat is always temperate and the underground water supply reasonably assured, the young leaves are covered on both surfaces with a very dense woolly indumentum which prevents free transpiration. The upper surface of the leaves, however, is glabrescent. A further point of interest is its immunity to moderate grass fires.

*Euphorbia polygona* Haw. is also usually found on quartzite outcrops but is not so obviously restricted to them as in the case of *O. arbuscula*. On rare occasions one finds associated with *E. polygona*, the unique minute parasite *Viscum minimum* Harv. Unlike other members of the genus the haustoria of *V. minimum* apparently ramify within the host and produce aerial plants of single internodes about 1 mm. long, which bear scarlet fruits many times their size.

An interesting example of intermittent or broken distribution is *Strelitzia augusta* Thunb. (wild banana). It is abundant on the Natal coast and in coastal Transkei, yet it is not recorded from East London to Uitenhage, but re-appears on parts of the Humansdorp coast. This is more interesting for the reason that conditions suitable to its growth occur along the coastal area from which it is absent, as proved by the ease with which it is established as an ornamental plant.

The absence of mangroves is noteworthy ; the conditions at the Fish River mouth and elsewhere appear to be suitable, but no species of this type penetrates so far along the south coast.

The fact that some forest trees, common to Natal and Knysna, do not occur locally is not strange since climatic conditions suitable for high forest growth are experienced only in a comparatively very small area in Albany and Bathurst.

There seems little doubt that the type specimen of *Phoenix reclinata* Jacq. was collected in Bathurst by the two Viennese gardeners Boos and Scholl. This is the southern-most record of the species, which, as at present delimited, occurs throughout Tropical Africa. It is one of the weaknesses of classification that an individual on the very outskirts of the species' distribution should occasionally be described as the type of that species, whereas in reality it may be the least typical.

In view of the imperfect distribution records of known species in South Africa and the regularity with which undescribed species are discovered, even in botanically well-explored areas, comparisons of numerical floristic data for different areas cannot be more than rough approximations. In support of this my notes on *Euphorbia* (1931) may be mentioned: Rogers (1909) listed 19 species of *Euphorbia* from this area whereas my records include double that number. A similar result was found after a revision of the local species of Cyperaceae and in the case of the genus *Eriospermum*, Rogers cites one species, whereas careful collecting revealed the presence of at least 9 distinct species. Percentages worked out on these figures would, therefore, vary considerably depending on the date on which calculations were made. Moreover, the species concept of botanical authorities lacks uniformity and definition, with the obvious result that the number of species recognised as valid, in any one group of plants, may vary considerably according to the concepts of the author, i.e. whether the tendency of the worker is to "split" or to "lump".

Making due allowance for these facts and the dates of publication of the relative monographs, the following figures of Phanerogams from different areas of the Cape are noteworthy.

	Area, Square Miles.	Families.	Genera.	Species.
Bolus (1905), South-western region (Cape).....	35,000	110	705	5,585
Schonland (1919), Uitenhage and Port Elizabeth.....	4,000	129	716	2,312
Phillips J. F. V. (1931), George, Knysna, Humansdorp.....	6,000	119	613	2,185
Albany and Bathurst.....	2,300	119	647	2,084

For its size, therefore, the area of Albany and Bathurst is obviously very rich in species. The detailed figures (approximate) are as follows:—

	Species.	Genera.	Families.
Gymnosperms.....	9	3	2
Monocotyledons.....	642	194	17
Dicotyledons.....	1,433	450	100
TOTALS.....	2,084	647	119

The families in order of numerical importance are:—

	Species.	Genera.
Compositae.....	270	70
Liliaceae.....	180	33
Gramineae.....	125	58
Leguminosae.....	125	32
Orchidaceae.....	95	25

	Species.	Genera.
Cyperaceae.....	90	17
Picoidaceae.....	80	8*
Asclepiadaceae.....	76	23
Euphorbiaceae.....	68	12
Scrophulariaceae.....	62	27
Iridaceae.....	55	20
Crassulaceae.....	52	3
Amaryllidaceae.....	50	15
Geraniaceae.....	34	5
Labiatae.....	32	10
Campanulaceae.....	32	9
Acanthaceae.....	31	13
Rubiaceae.....	30	15
Celastraceae.....	28	5
Umbelliferae.....	24	14
Stereuliaceae.....	22	3
Convolvulaceae.....	22	4
Anacardiaceae.....	21	4
Cruciferae.....	18	6
Thymelacaceae.....	17	5
Santalaceae.....	17	5
Polygalaceae.....	16	3
Rosaceae.....	15	5
Rutaceae.....	15	7
Ericaceae.....	14	1
Malvaceae.....	14	6
Oxalidaceae.....	13	1
Gentianaceae.....	13	3
Selaginaceae.....	13	3
Caryophyllaceae.....	12	7
Solanaceae.....	12	2
Boraginaceae.....	11	8
Ebepaceae.....	11	2
Juncaceae.....	11	2
Chenopodiaceae.....	10	4
Loranthaceae.....	10	2
Rhamnaceae.....	10	6
Restiaceae.....	10	5
Loganiaceae.....	9	5
Vitaceae.....	8	2
Naiadaceae.....	8	6
Amarantaceae.....	7	5
Apocynaceae.....	7	4
Cucurbitaceae.....	7	4
Flacourtiaceae.....	7	3
Capparidaceae.....	6	3
Oleaceae.....	6	2
Proteaceae.....	6	3
Haemodoraceae.....	6	4

\* The genus *Mesembryanthemum* considered in the broad sense.

The following families are represented by: (5) species Dipsacaceae, Portulacaceae, Primulaceae, Ranunculaceae, Sapindaceae; (4) Myricaceae, Urticaceae, Verbenaceae, Zygophyllaceae, Commelinaceae; (3) Araliaceae, Fumariaceae, Meliaceae, Myrsinaceae, Myrtaceae, Moraceae, Plantaginaceae, Plumbaginaceae, Dioscoreaceae; (2) Bignoniaceae, Bruniaceae, Gesneriaceae, Haloragaceae, Hypericaceae, Icacinaceae, Lentibulariaceae, Linaceae, Melianthaceae, Menispermaceae, Ochnaceae, Passifloraceae, Samydaceae, Sapotaceae, Tiliaceae, Ulmaceae; (1) Aquifoliaceae, Balanophoraceae, Combretaceae, Cornaceae,

Cytinaceae, Droseraceae, Erythroxyleae, Goodeniaceae, Hamamelidaceae, Illecebraceae, Laurinaceae, Lythraceae, Nymphaeaceae, Olacineae, Olineae, Papaveraceae, Piperaceae, Pittosporaceae, Resedaceae, Salvadoraceae, Saxifragaceae, Valerianaceae, Violaceae, Aroideae, Hydrocharideae, Musaceae, Palmaceae, Typhaceae.

A comparison of the number of species in some of the more important genera with those given by Schonland and J. F. V. Phillips is also instructive :—

Genus.	Albany and Bathurst.	Uitenhage and Port Elizabeth.	George, Knysna and Humansdorp.
Mesembryanthemum .....	60	64	50
Senecio.....	56	60	50
Crassula.....	41	49	36
Helichrysum.....	41	41	39
Euphorbia.....	38	22	19
Pelargonium.....	27	35	41
Aloe.....	20	16	*
Ornithogalum.....	20	16	*
Albica.....	19	19	*
Hermannia.....	18	22	20
Indigofera.....	17	22	30
Rhus.....	17	21	*
Scirpus.....	17	14	*
Ficinia.....	16	23	24
Oxalis.....	16	19	18
Cyperus.....	16	14	*
Asparagus.....	16	12	*
Erica.....	14	30	93

\* 15 species or less.

The outstanding feature in this table is the relative numbers of species of *Erica* showing a large increase towards the south-western Cape.

In addition to the indigenous species in the Divisions of Albany and Bathurst there are, very roughly, 85 non-native species which are in some measure becoming naturalised. Salisbury (1919) deals with many of these.

Further, the foregoing summary deals with Phanerogams only and records of Cryptogams have not been included. It may be of interest, however, to record the presence of about 65 ferns.

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## Chapter 10.

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PLANTS OF ECONOMIC IMPORTANCE.

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## CHAPTER 10.

## PLANTS OF ECONOMIC IMPORTANCE.

This is a brief introduction only to the plants of economic importance in the Albany and Bathurst divisions and rarely is reference made to species outside the area. Observations on the palatability of various plants are mostly the result of personal observations and, as is to be expected, are, in many cases, verifications of facts recorded by practical farmers. On the other hand attention is drawn to a number of little known plants worthy of further investigation. For more detailed information on poisonous and medicinal plants reference should be made to the publications of Steyn (1934) and Watt and Brandwyk (1932). Both these modern works add considerably to our knowledge of South African plants and contain references to the more important literature on the respective subjects dealt with. Henrici, Official Science Bulletin No. 134 (South Africa) records important facts on the pastures of Albany, and has to her credit a number of other papers on the pastures of South Africa. An article by E. P. Phillips on Economic Plants of South-Africa appeared in the Official Year Book (South Africa), 1927.

As regards the sequence adopted : Taxaceae are followed by the families of Monocotyledons, excluding grasses, arranged according to E. P. Phillips' *Genera of Flowering Plants* (1926) and after them the families of Dicotyledons are listed alphabetically. A chapter has been devoted to grassveld in the main body of this work. Few Monocotyledons, other than grasses, are of much value as fodder plants, whereas many have been proved toxic, some extremely so ; others suspected of toxic properties have yet to be investigated.

Taxaceae : *Podocarpus latifolius* R. Br. (yellowwood) and *P. falcatus* R. Br. (Outeniqua or bastard yellowwood) are two notable forest trees which occur locally. In some of the bush patches and forests, unfortunately comparatively small, quite fair sized trees (trunks 18 to 20 ft. in circumference) may still be found but most of the large trees were chopped down and hand-sawn for building purposes in the early days of European colonisation. The wood, particularly of the latter species, has been used very extensively throughout South Africa for this purpose.

## MONOCOTYLEDONS.

Cyperaceae : Few of these are of any feeding value although the young growth of some species of *Ficinia* is eaten by sheep. Their ecological importance has been referred to elsewhere.

Liliaceae : Some of the most deadly vegetable poisons belong to this family, and annually cause considerable mortality among stock. Species in a number of genera have been proved toxic, two of these *Urginea altissima* Baker (slangkop) and *Ornithogalum thyrsoides* Jacq. (chicheerinchee) occur locally and the respective genera contain other very toxic plants. *Aloe ferox* Mill. is very abundant in the eastern Cape and is specifically equal to the plant in Riversdale district, etc., which is the main source of commercial "Cape



aloes." Animals and ostriches eat the seedlings of *Aloe* spp. and *Asparagus* spp. *Asparagus Kraussii* Baker and *A. medeoloides* Thunb. are said to taint milk. Natives utilise many different plants in the family for medicines, *Asparagus* spp. being prominent among these. Horticulturists are paying increasing attention to indigenous species.

The leaf fibre of *Sansevieria thyrsiflora* Thunb. (placed by Hutchinson, 1934, under Agavaceae) is used by weaver birds for building their nests. Stock graze it sparingly.

Amaryllidaceae: *Buphane disticha* Herb. (gifbol) is widely spread in South Africa and since the early days of colonisation has attracted attention on account of its toxic properties. It has been used extensively by Bushmen as a source of arrow poison; it has caused severe mortality among stock and even in these days figures prominently in homicidal cases among natives. *Haemanthus amarylloides* Jacq. and other species outside this area have also been proved poisonous. Such plants as *Nerine* spp., *Cyrtanthus* spp., *Haemanthus* spp. are of special horticultural value.

Iridaceae: Comparatively few species have been subjected to feeding tests and many of the "tulps" *Homeria* spp. and *Moraea* spp. suspected of toxic properties await investigation. *Moraea polystachya* Ker (blou tulp) has unquestionably caused a large mortality among stock, particularly cattle. It is widely spread in the Cape and on one occasion I passed through a mauve sea of its flowers for about 15 miles between Breakfast Vlei and Debe Nek. Animals from unfested veld coming into "tulp" veld are most likely to suffer, and, in ox-wagon transport days, whole spans of trek oxen died within a few hours after grazing for the first time in *M. polystachya* veld. *Homeria collina* Vent. is also poisonous but not so widespread or abundant as *M. polystachya*. *Bobartia Burchellii* Baker and *B. spathacea* Ker have increased rapidly in overgrazed sourveld in this area. Many species of South African *Iridaceae* are popular garden plants.

#### DICOTYLEDONS.

Acanthaceae: These are, for the most part, constituents of undergrowth in bush and karroid scrub and nearly all those in the latter habitat are eaten readily by stock, the more important being *Justicia capensis* Thunb., *J. orchidioides* Linn., *J. protracta* And., *Isoglossa ciliata* Lindau and *Barleria obtusa* Nees.

Amarantaceae: Mostly introduced annual weeds, some of which (*Amaranthus* spp.) are eaten when young by natives, pigs and fowls.

Anacardiaceae: The young shoots and leaves of *Rhus longispina* E. & Z. and *R. undulata* Jacq., and probably other species to a lesser extent, are eaten by stock; generally speaking, however, it is not an important family in this respect. *Heeria mucronata* Bernh. is browsed moderately, but is not considered by farmers of much nutritive value.

*Rhus Legati* Schönl. (red currant) produces a timber of fair quality, but in this area does not grow in sufficient quantity or to a suitable size for commercial exploitation. The trunk of *Loxostylis alata* Spreng. is used to some extent in farming practice.

*Harpephyllum caffrum* Bernh. (kaffir plum) is a small or medium sized evergreen tree of considerable ornamental merit for street decoration. The fruits, about the size of pigeons' eggs, are edible and much sought after, mainly by children.

**Apocynaceae** : Some species have edible and others poisonous fruits. In Fl. Cap. vol. 52 p. 499, only one species of *Carissa*, *C. Arduina*, is recognised from Albany, whereas observant farmers distinguish two distinct "kinds," one with scarlet berries and the other with dark purple berries. I investigated this question and was able to correlate the differences noted in the fruits with distinguishing floral characters, and in addition to *C. bispinosa* Desf., (= *C. Arduina*), *C. hacmatocarpa* DC. should be resuscitated. The fruits of both are edible although much smaller than those of the better known *C. grandiflora* A.DC. (amatungulu) from Natal.

*Acokanthera venenata* G. Don. (Bushman's poison, gifboom etc.) is highly toxic in all parts, having frequently been the cause of death in both animals and man. It has been extensively used in the past by Bushmen and Hottentots for arrow poison and by other natives for various purposes. *A. spectabilis* Hook., which has longer flowers and is more coastal in its distribution than *A. venenata*, may be only a habitat form of the latter.

*Gonioma Camassi* E. Mey. (kamassiehout, South African boxwood, etc.) yields a durable wood : reports state, however, that it may affect workers adversely owing to toxic emanations.

**Araliaceae** : *Cussonia spicata* Thunb. (cabbage tree, M'senga) is common in scrub and bush vegetation and is claimed by some to be comparable to "lucerne" in nutritive value, but this is certainly an exaggeration. The root system is large, functioning as a water and food storage organ, and in times of drought the leaves remain fresh and are chopped off to sustain hungry animals. *Cussonia paniculata* E. & Z. is said to have similar nutritive properties but I cannot verify this statement. The wood of species of *Cussonia*, although comparatively soft, is tough and fibrous and is used by farmers for the manufacture of wagon brake-blocks.

**Aselépniaceae** : Watt and Brandwyk (1932) cite numerous examples from this family as used in native medicine. Comparatively few species are poisonous : the genus *Cynanchum*, however, is somewhat of an exception because most species have either been proved poisonous to stock or are suspected of toxic properties. A considerable amount of uncertainty exists as to the properties of *Sarcostemma viminale* R.Br. I have observed it grazed heavily by stock in certain localities and not in others, and yet no specific differences are apparent. It is possible that it occurs in different physiological "forms" or "strains." Marloth (1917) stated that it was toxic but later in a letter to me he admitted it to be edible. (Steyn 1934) administered to a sheep, with negative results, material which I forwarded from East London. Since then he has had positive toxic results with a plant from Namaqualand, which, so far, I have not been able to distinguish from this species. *Secamone* spp. require investigation. *Fockea edulis* K. Schum. is a climber with a large tuberous rootstock and as the name implies, is edible. The aerial portions are eaten by animals and the tubers by natives. The tuber may be 10-30lbs. or more in weight and the central soft, pithy portion is an excellent alternative to watermelon rind for the preparation of preserve or "konfynt." The tubers of species of *Brachystelma*, *Asclepias* and *Schizoglossum* etc. are often eaten raw by natives.

Succulent species of *Stapelia*, *Duvalia*, *Huernia*, etc. were said to be an important item in the diet of ostriches when these birds were farmed extensively in this area 20 and more years ago.

**Aquifoliaceae** : *Ilex mitis* Radlk. (Cape holly, waterhout). A fair timber tree but not much utilised.

Bignoniaceae : *Tecomaria capensis* Spach. (often referred to under the name *Tecoma*), is eaten readily by stock in scrub veld and is becoming somewhat scarce : largely used as an ornamental shrub or hedge. *Rhigozum obovatum* Burch. (drie-doorn) is restricted to karroid scrub veld and is usually dry and woody, but when in leaf is readily grazed by stock. During favourable seasons it produces an abundance of yellow, bell-shaped flowers and transforms the otherwise sombre landscape into one of exceptional beauty.

Boraginaceae : *Ehretia rigida* Druce (= *E. hottentotica* Burch., Cape lilac). This is one of the more important constituents of inland dry scrub and is much relished by stock, all shrubs within reach being heavily cropped. It is also a most decorative shrub.

Campanulaceae : Generally speaking this family is unimportant as regards fodder plants ; *Lightfootia tenella* A.DC. and *L. albens* appear to be eaten slightly ; some species of *Wahlenbergia* and *Lobelia* make useful and attractive subjects for an herbaceous border and more species deserve a trial by horticulturists.

Capparidaceae : The young shoots of *Capparis citrifolia* Lam. and *C. oleoides* Burch. are eaten by stock in scrub veld and *Maerna triphylla* Dur. & Sch. to a lesser extent. *Cadaba juncea* Harv. is also palatable to stock but, owing to its stiff leafless growth and scattered distribution, it is of little real value.

Caryophyllaceae : Species of *Dianthus* might be of value in the horticultural trade for hybridising.

Celastraceae : I have it on Dr. S. Schonland's authority that various species of *Gymnosporia* (even some thorny ones) are important food plants for Persian sheep in scrub veld ; also that the drupes of *Cassine croceum* DC. are much relished by sheep and that the foliage is eaten by stock generally. A sample of the leaves and bark of *Gymnosporia acuminata* Szysz., "silk bark," a shrub found frequently in our area, was forwarded from Swaziland to the Imperial Institute, London, and was found to contain a gutta percha-like substance of good commercial quality.

Such species as *Cassine Kraussiana* Bernh. (blackwood) and *Pteroclastrus tricuspidatus* Sond. (Cherry wood) yield a small amount of timber ; the leaves and bark of the latter have also been used to some extent as a tanning agent, and the gum from the roots is used by natives to repair their earthenware.

Chenopodiaceae : The most important indigenous species is *Exomis oxyrioides* Fenzl, a robust perennial herb or half-shrub which is readily grazed by all kinds of stock. The plant is most abundant near waste places and along roadsides. Shrubby *Salsola* spp., which are generally nutritive, do not occur in this area, but the annual *S. Kali* Linn., although somewhat noxious in its mature state, is a useful fodder plant when young, particularly for sheep ; its cultivation, however, should not be encouraged. Introduced "salt bushes," such as *Atriplex halimus* Linn., *A. halimoides* Lindl. and *A. semibaccata* R. Br. are cultivated fairly extensively as fodder plants.

Compositae : Numerically the largest family in the world, containing approximately 10 per cent. of the total number of species in South Africa, is second in importance agriculturally to the Gramineae. No timber trees are represented, many shrublets are of excellent feeding value ; many species, particularly among the herbs, are poisonous ; others again are used medicinally, for example, *Artemisia afra* Jacq. (wilde-als, wormwood) as a general tonic and for colds etc. ; *Brachylaena elliptica* Less. (bitter blaar) for diabetes. To what extent these are efficacious is indefinite, the latter is certainly relished by animals and heavily cropped in scrub veld.

The most important fodder plants throughout the Karroo are species of *Pentzia*; *P. globosa* Less. and *P. incana* O.K. (sweet karroo, skaapbos, etc.) are examples, and are present in fair quantity in Albany amongst dwarf bushes in the dry karroid veld north of Grahamstown and particularly in the Fish River valley. In the same veld are other good fodder species such as *Aster muricatus* Less. (blauwblommietjie), *A. hyssopifolius* Berg., *Eriocephalus ericoides* Druce (kapokbos) rather scarce, *Gamolepis trifurcata* Less. and *Pentzia sphaerocephala* DC. (Karoo bush) scarce. The succulent half-shrub, *Othonna triplinervia* DC. has been largely eaten out from the undergrowth of scrub bush. *Metalsia muricata* Less. is readily eaten by sheep for short periods, possibly acting as a tonic.

*Aster filifolius* Vent. (draaibos, numbossie, etc.), a shrub up to 3 ft. high, occurs in dry scrub veld north of Grahamstown where it is generally recognised as an excellent fodder plant, yet, as with *Chrysocoma tenuifolia* Berg., it may have fatal results if taken in overdoses. During 1930, when stationed in Grahamstown, I investigated with Mr. R. Paine (D.V.O.) a case in which 20 sheep died within about three days after being placed in a camp in which *Aster filifolius* was dominant and just coming into flower. The sheep had been driven from a neighbouring farm and had little to eat on the road; consequently, when driven into the camp in question they were abnormally hungry. A bag of the *A. filifolius* was forwarded to the Division of Veterinary Services, Onderstepoort, where Dr. D. G. Steyn produced identical symptoms in feeding tests as found in the dead sheep in the veld. -

*Chrysocoma tenuifolia* Berg., which has a wide range of distribution in South Africa, is usually grazed to a certain extent, and may be a useful standby in times of drought. It has, however, caused deaths amongst goats and the following summary by Dr. Steyn is of particular importance as a guiding principle in similar investigations: "It is evident that Angora goats, after having undergone a preliminary treatment with non-toxic doses of 'bitterbossie,' can tolerate, to a remarkable degree, such quantities of the plant as would have caused death in untreated animals." Neither *Aster filifolius* nor *Chrysocoma tenuifolia* should be considered poisonous plants in the ordinary sense of the word. An overdose of numerous otherwise beneficial substances would have harmful effects.

The genera *Senecio* and *Dimorphotheca* contain most of the truly poisonous plants. The former represented by *S. retrorsus* DC., *S. ilieifolius* Thunb., and other related species, cause diseases of the liver in both man and animals, resulting in extensive mortality in the latter. Humans are affected in areas (Riversdale and George) where local wheat contaminated with *Senecio* seed is ground for bread-making. *Dimorphotheca Zeyheri* Sond., *D. cuneata* Less. and other species outside our area, all going under the common name "bitou," cause poisoning under certain conditions due to the formation of prussic acid. The herb *Matricaria nigellifolia* DC. (staggers weed), which grows in temperate situations, causes the disease known as staggers or pushing disease, etc.

In cases of overstocking and where faulty methods of veld management have been practised, *Elytropappus Rhinocerotis* Less. (rhenosterbos), *Pteronia incana* DC. and *Helichrysum* spp. (*H. anomalum* Less., etc.) are likely to increase rapidly and in some localities have already become a serious menace to good grassveld.

*Xanthium* spp. (burweeds), *Tagetes minuta* (khaki bush, kakiebos or Mexican marigold), are noxious weeds restricted mainly to cultivated lands, road sides, and waste places.

Convolvulaceae: *Cuscuta medicaginis* C. H. Wright and *C. chinensis* Lam. (dodders) are harmful parasites on lucerne and other plants. Some species of *Convolvulus*, although possessed of attractive flowers, are prolific in seed production and often difficult to eradicate. Species of *Ipomoea*, such as *I. argyreoides* Choisy are particularly attractive in the veld.

Cornaceae: *Curtisia faginea* Ait. (assegai wood) was greatly prized by early colonists for wagon building owing to its great durability; also used extensively by natives.

Crassulaceae: The importance of this family is mainly from the standpoint of poisonous plants; the genus *Cotyledon* being the most noteworthy. Unfortunately, however, the species in many groups are ill defined and satisfactory classification is very greatly complicated by the frequency and facility with which natural hybridisation takes place. *C. orbiculata* Linn. and some of its "forms" have been proved poisonous to stock and fowls. A number of species occurring outside our area cause the disease known as "krimpsiekte."

Many species of *Crassula* and *Cotyledon* are collected extensively for planting on "rockeries," the dwarf forms from Namaqualand being more attractive for this purpose than local species. Dr. S. Schonland informs me that *Crassula expansa* Dryand. is eaten by sheep.

Cruciferae: The indigenous species in this area are of little economic importance. Some species of *Helipila* may be grazed slightly; a few are worthy of horticultural attention.

Cucurbitaceae: Few South African species are edible; some have been proved poisonous, *Cucumis myriocarpus* Naud., *Melothria punctata* Cogn. (under certain conditions) and many others are suspected of toxic properties.

Ebenaceae: Both *Royena cordata* E. Mey. (blinkblaar) and *Euclea undulata* Thunb. (guarri), which are frequent in karroid scrub, are said to be eaten by stock but are not considered of great nutritive value. *Royena lucida* Linn. (swartbos) becomes a fair sized tree under favourable conditions.

Ericaceae: Some of the species of *Erica* are dominant over small areas and are particularly attractive when in flower, such as *E. chamissonis* Kl. ex. Benth., *E. curviflora* Linn. and *E. caffra* Linn., all of which have been cultivated in Europe for nearly a century or more.

Euphorbiaceae: The most important genus is *Euphorbia* and the name seems to be considered by many as synonymous with poison. This is due to the irritant properties of the latex of many species, but Steyn has had negative results from feeding tests with a number of suspected species. On the other hand a number of species are known to be good fodder plants, particularly useful in times of drought. These are represented locally by *E. inermis* Mill. (fingerpol), *E. gorgonis* Berger and *E. hastisquama* N.E. Br., all dwarf unarmed species. *E. pentagona* Haw. with spiny peduncles, is eaten somewhat by large game. Many species outside our area are also eaten by stock, the more important being *E. coerulescens* Haw. and *E. esculenta* Marl. That the sap from these edible species is an irritant to human throats has been proved to the great discomfort of the writer. *E. Cooperi* N.E. Br. from the Transvaal, which is not eaten, has a particularly potent latex. A light smear on the face or tender skin causes blistering within a short period. *E. virosa* Willd., in Namaqualand, is reputed to have been used extensively by Bushmen as a source of poison. The latex of *E. triangularis* Desf. and probably also of *E. tetragona* Haw. has been utilised

in the eastern Cape for the manufacture of inferior rubber and gum for "chewing gum" and is at present used in the confectionery trade in King Williams Town.

*Phyllanthus verrucosus* Thunb. is grazed readily by stock and is found both in karroid scrub and "broken" grassveld. Many species of the family have been used in native medicine.

**Ficoidaceae** : Within the past few years the large genus *Mesembryanthemum* has been sub-divided into over 125 smaller genera and the reclassification is not yet complete. Using the name in the wide sense, many species are eaten by stock, and some local ones such as *M. floribundum* Harv., *M. megarrhizum* Don, *M. tuberosum* Linn. are considered good stock and ostrich food. *Glottiphyllum grandiflorum* N.E. Br. and *G. longum* N.E. Br. have very soft juicy leaves and birds (doves) eat them, quite likely both as a source of moisture and of mineral salts. *Galenia spathulata* Fenz. has been mentioned by farmers on several occasions as being readily grazed by stock and I have often had proof of this. It is a useful plant on old disused lands.

Some species of *Mesembryanthemum* contain ferments. These are used for making intoxicating drink and by some Europeans in bread-making as a substitute for bought yeast. One teaspoonful of the dried roots of *M. tuberosum* Linn. are used to raise sufficient dough for about three loaves of bread with excellent results.

Other species of the family are used in various ways, particularly in native medicine.

**Geraniaceae** : Many species are used medicinally, particularly in cases of dysentery and diarrhoea, the most common local example is *Monsonia ovata* Cav. It is also eaten by stock. I have been informed that stock also browse on *Pelargonium peltatum* Ait. but I have not actually observed this. No species has been proved poisonous in the Union of South Africa.

**Icacinaceae** : *Apodytes dimidiata* E. Mey. (white pear) is a useful timber tree but not abundant in this area.

**Labiatae** : Extensively used in native medicine. The leaves of *Leonotis* species (wilde dagga, wild dagga, not to be confused with "dagga" or "Indian hemp," *Cannabis sativa* Linn.) are smoked, either pure or mixed with tobacco and are reputed to contain a habit-forming narcotic principle. *Lasiocorys capensis* Benth. is fairly readily eaten by stock and is frequent in semi-karroid veld.

**Leguminosae** : In this family are represented medicinal, poisonous and nutritious plants. Some are good stock food under certain conditions and poisonous under others, e.g. *Medicago sativa* Linn. (lucerne), which may, if eaten at the wrong time, cause "hoven" or "opblaas" due to rapid fermentation. The roots of some species of *Tephrosia* are used as fish poison but do not affect the flesh for human consumption; others like *T. grandiflora* Pers. are used as parasiticides.

The most important indigenous fodder species in this area are probably *Schotia speciosa* Jacq. and *S. latifolia* Jacq. (boerboon, paarboon), particularly the former which is grazed heavily in the karroid scrub of the Fish River valley. The "beans" were an item in the diet of natives and early colonists.

*Acacia Karroo* Hayne (thorn tree, Acacia, mimosa) is of value as a fodder plant. In some areas, however, it has become a pest owing to its rapid increase

due to changed methods of veld management, not necessarily overstocking. It is safely and effectively killed by poisoning with arsenic pentoxide,  $\frac{1}{2}$  lb. per gallon water or a stronger solution of Arsenite of Soda (Dyer, 1930).

Loganiaceae: Several species are used in native medicine and none appears to be poisonous. *Buddleja salviifolia* Lam. is a useful ornamental shrub.

Malvaceae: A few species are used medicinally; *Malva parviflora* Linn. (mallow, kiesieblaar) has toxic effects on animals if they are exercised after feeding on it. Many species contain fibre of moderate quality.

Meliaceae: The tree *Ptaeroxylon obliquum* Radlk. (sneezewood, nieshout) produces the best fencing poles in South Africa and has been used very extensively for this purpose. The wood is extremely hard and unsuitable for fine work; it is powdered and used as snuff by natives. *Ekebergia capensis* Sparm. (essehout, Cape ash) produces fair timber.

Myrsinaceae: *Myrsine (Rapanea) melanophloeos* R. Br. (Cape beech, wit beukenhout) is a useful timber tree of moderate size.

Oleaceae: Noted for timber trees, the most important being *Olea laurifolia* Lam. (black ironwood, swart ysterhout). The young shoots of *O. verrucosa* Lam. (wild olive) are eaten by stock. *Jasminum multipartitum* Hochst. and *J. angulare* Vahl would probably repay cultivation as ornamental plants.

Papaveraceae: *Argemone mexicana* L. (Mexican poppy) is a widely spread noxious weed.

Pittosporaceae: *Pittosporum viridiflorum* Sims, when growing in forest, produces a timber of fair quality.

Plumbaginaceae: The shrub *Plumbago capensis* Thunb. is common in coastal and inland scrubveld and is readily eaten by all kinds of stock. It is now widely cultivated in South Africa as an ornamental shrub or hedge and has been introduced to many other parts of the world.

Polygalaceae: *Polygala asbestina* Burch. is much eaten by stock, particularly sheep, but is not sufficiently abundant in this area to be of great importance. Several species are used medicinally by natives.

Polygonaceae: More weeds than useful plants; *Emex australis* Steinh., one of the "duiveltjies," is usually eaten by stock.

Portulacaceae: The importance of this family is due to the abundance and fodder value of *Portulacaria afra* Jacq. (spekboom, elephants' food). There are, however, two physiological forms of this species, one of which is comparatively rare and not nearly so readily eaten by stock as the other. So far no morphological difference has been observed nor has the cause of the difference in palatability between the two forms been satisfactorily explained.

Rhamnaceae: Of little real importance; the small fruits of *Scutia myrtina* Kurz are eaten by children and birds; the hooked thorns of this species are usually a severe hindrance to persons attempting to penetrate dense scrub bush.

Rubiaceae: Many species are used medicinally by natives but few in our area are of much economic importance. The small shrub *Randia rudis* E. Mey. ex. Harv., which occurs frequently in inland scrub, is readily eaten by stock and is apparently of good feeding value. *Anthospermum aethiopicum* Linn. is grazed to some extent as also a few other under-shrubs.

Rutaceae: Little use is made of local species although *Barosma venusta* E. & Z. yields good "buchu" oil comparable with that obtained from *B. betulina* B. & W. of south-western Cape. A few fine trees of *Calodendron capense* Thunb. (Cape chestnut) occur and the species is used with excellent effect for ornamental purposes in towns. Natives have a number of medicinal uses for *Fagara capensis* Thunb. (knobwood) and also make sticks from it. *Agathosma claviseipala* R. A. Dyer is said to cause tainting of milk and butter.

Salvadoraceae: The young shoots of *Azima tetraacantha* Lem. (stinkbos) are grazed by all stock, and are reputed to cause tainting of milk and butter. The term "bush butter" is applied to the tainted product, but *A. tetraacantha* may not be the only plant responsible.

Samydaccae: *Trimeria trinervis* Harv., a tree producing wood of limited value.

Santalaccae: *Osyris compressa* A.DC. (= *O. abyssinica* Hochst., bergbos), has a wide distribution in Africa and is used for tanning, formerly more extensively so than at the present time.

Some species of *Thesium* have been suspected of toxic properties, others are used medicinally by natives.

Sapindaceae: The seed of *Pappea capensis* E. & Z. (pruinboom, oliepitte), a shrub or small tree, contains a good percentage of oil suitable for soap making; it has also been used for the treatment of certain diseases. It is common in the karroid scrub of the Fish River valley and affords good grazing for all types of stock. *Hippobromus pauciflorus* Radlk. (*H. alatus* E. & Z., basterperdepis), is used widely by natives. *Dodonaea Thunbergiana* E. & Z. is becoming popular as a hedge plant.

Sapotaceae: *Sideroxylon inerme* Linn. (white milkwood) develops into a moderate sized timber tree. On some farms the trunks are hewn out into troughs for feeding "licks" to stock.

Scrophulariaceae: Relatively of little economic importance; many of them are used medicinally by natives. *Sutera pinnatifida* O. Kuntze is readily eaten by stock and so also *S. atropurpurea* Hiern, which latter, however, is not found in any appreciable quantity in Albany. Many species such as *Aptosimum depressum* Burch. (Karoo violet), *Teedia lucida* Rudolphi, *Halleria lucida* Linn., *Nemesia* spp., etc., have beautiful flowers and are of considerable horticultural value.

Selaginaceae: The shrublet *Walafrida geniculata* Rolfe, which is common in limited areas in karroid veld, is readily grazed by stock. *Selago corymbosa* Linn., on the other hand, is only very lightly grazed by stock and is liable to become a pest in sheep grassveld. It is controlled to a certain extent by insect pests and the fact that the seedlings are somewhat intolerant of shade suggests other methods of control (Dyer, 1932).

Solanaceae: Many species now in South Africa, particularly those of *Solanum*, were introduced and have been proclaimed noxious weeds. Of the introductions into our area *Datura Stramonium* Linn. (stinkblaar) and *Nicotiana glauca* Graham have been proved toxic. The green fruits of *Solanum nigrum* Linn. are toxic, whereas when ripe they make excellent jelly. The ripe fruits of *S. sodomium* Linn. are frequently eaten by sheep without ill effects, yet most species are suspected of toxic properties. At least *Solanum aviculatum* Ait. and *S. giganteum* Jacq. are host plants for "fruit fly." *Physalis*



*peruviana* Linn. (Cape gooseberry, which incidentally is from South America,) is now largely used for jam-making. *Lycium* spp. are grazed to a certain extent by stock.

Species in various genera are used in native medicine.

Sterculiaceae : Only one of the 18 species of *Hermannia*, namely *H. pallens* E. & Z., appears to be of any appreciable value as a stock food. It is nibbled down to the hard woody shoots by sheep, and is frequent on the Dikkop Flats near Carlisle Bridge. *Dombeya tiliacea* Planch. is a shrub of considerable decorative value. Some species are used medicinally by natives.

Tiliaceae : Both *Grewia robusta* Burch. and *G. occidentalis* Linn. are eaten by stock in karroid scrub veld, the former being more common in the Karroo, whereas the latter extends south from Tropical Africa.

Ulmaceae : *Celtis Kraussiana* Bernh. (white stinkwood, camdeboo stinkwood, witstikhoud, etc.) is a useful tree, but although it has been recorded, I have not seen it here.

Verbenaceae : *Lantana salvifolia* Jacq. and *Lippia asperifolia* Rich. are eaten by stock to some extent and both are used medicinally by natives.

Vitaceae : Stock are said to eat the leaves of some *Cissus* spp. ; the fruit of *Cissus capensis* Planch. is used for making jam.

Zygophyllaceae : *Tribulus terrestris* Linn. (duiweltjie, devil's thorn, etc.) causes "geeldikkop" in sheep when growing under certain climatic and soil conditions. It may, however, be quite a useful fodder plant in irrigated lands in the Fish River valley. It is probable that some species of *Zygophyllum* are eaten by stock.

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**APPENDIX I: PERSONAL PUBLICATIONS.**

**APPENDIX II: NEW COMBINATIONS.**

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34. "A Note on the Occurrence of Vivipary in *Haworthia truncata*, *Schoenl.*," S. Afr. Journ. Sc., Johannesburg, 1936 (1937).



## NEW COMBINATIONS.

1. ***Alepidea capensis*** (Berg.) R. A. Dyer; *Jasione capensis* Berg., in Act. Ups. **3**, 187, t. 10 (1780); Wolff in Engl. Pflanzenr. Heft **61**, 4, 228, 104 (1913); *Astrantia ciliaris* L. f. Suppl. 177 (1781) in part acc. to Dümmer in Trans. Roy. Soc. S. Afr. **3**, 1, 13 (1913); *Alepidea ciliaris* (L.f.) Delar. Eryng. Hist. 19, t. 1 (1808); Sond. in Harv. & Sond. Fl. Cap. **2**, 534 (1861-62); Wolff l.c. 103.

*Note*.—According to International Rules of Nomenclature Dümmer, l.c., is incorrect in the use of the specific name *A. ciliaris* but I am not in a position to investigate this fully.

2. ***Cynanchum ellipticum*** (Harv.) R. A. Dyer; *Bunburia elliptica* Harv. Gen. S. Afr. Pl. ed. 1, 417 (1838); *Cynanchum capensis* Thunb. not of L.f. nor R. Br., acc. to Brown in Dyer, Fl. Cap. **4**, 1, 751 (1908).
3. ***Rorippa fluviatilis*** (E. Mey. ex Sond.) R. A. Dyer; *Nasturtium fluviatile* E. Mey. ex Sond. in Harv. & Sond. Fl. Cap. **1**, 21 (1859-60); Burt Davy in Fl. Transvaal, **1**, 125 (1926).
4. ***Rorippa caledonica*** (Sond.) R. A. Dyer; *Nasturtium caledonicum* Sond. and *N. fluviatile* E. Mey. var. *caledonicum* Sond. in Harv. & Sond. Fl. Cap. **1**, 21 (1859-60); Burt Davy in Fl. Transvaal, **1**, 125 (1926).

*Note*.—This last name does not occur in the preceding account but it is considered advisable to make the combination for the sake of uniformity in classification.

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## Illustrations.

(Photographs by the Author.)

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1. Initial stage of halosere : a mudbank at Bushmans River mouth submerged at high tide : *Spartina stricta* Roth. partly submerged, and on the more stable mud in the foreground, *Suaeda maritima* Dum., *Chenolea diffusa* Thunb., *Salicornia* spp., *Limonium scabrum* O.K. (Statice) and *Triglochin bulbosa* Linn.



2. Intermediate zone between halosere and psammose : association of *Juncus acutus* L., *Scirpus notosus* Rottb., *Helichrysum vellerum* R. A. Dyer, *Microstaphium populifolium* Druce (centre) and *Sporobolus pungens* Kunth (small grass in back ground) ; Bushmans River mouth, west bank.



3. Lagoon sand-binder, *Delosperma* sp. nov. (*Mesembryanthemum*); Kowie.



4. Abrupt transition from halosere to xerophytic lagoon bank bush: *Salicornia* spp., *Suaeda maritima* Dum., etc., submerged at high tide, and on the bank *Euphorbia triangularis* Desf., *Aloe pluridens* Haw., *Encephalartos* sp., *Schotia speciosa* Jacq., *Capparis citrifolia* Lam. and *Azima tetraantha* Lam.; near Bushmans River mouth.



5. Psammophilous macchia and littoral scrub: over the crest of the first sand dunes on the east bank of Bushmans River: *Aloe africana* Mill. in foreground with *Pterocelastrus tricuspidatus* Sondl., *Gymnosporia* sp. and *Mimusops caffra* DC.

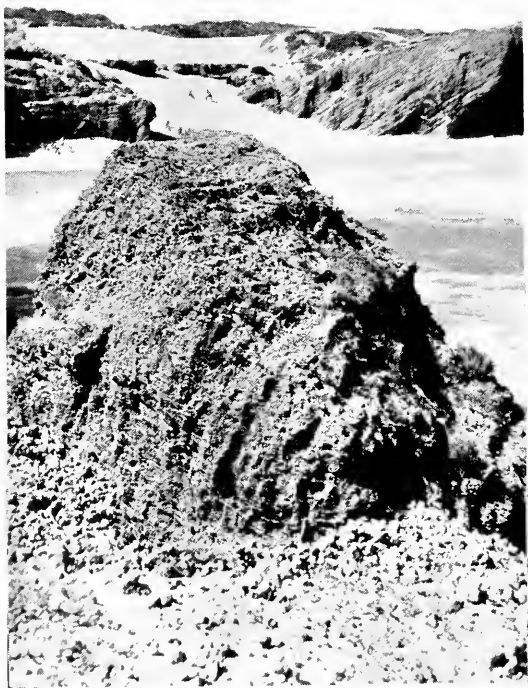


6. Sand dune stabilisation by *Ehrharta gigantea* Thunb., followed by *Microstephium populifolium* Druce, *Unidum suffruticosum* Cham. & Schl., *Anthospermum littorale* L. Bolus and *Passerina rigida* Wikstrom in the foreground on a rocky foundation: near Bushmans River mouth.



7. Strand vegetation partly destroyed by man, resulting in "blowouts" and throwing back of plant succession : near Bushmans River.





8. Lithosere, near Bushmans River mouth: rocks, formed from raised beach, exposed to sea spray: plant succession advances no further than the pioneers, *Gazania uniflora* Sims, *Limonium scabrum* O.K., *Salicornia* sp., *Delosperma* sp. nov.



9. Lithosere : rocky headland slightly more protected and with more sandy pockets than in Fig. 8 : the ubiquitous *Osteospermum moniliferum* L. closely pressed to the rock surface at the extremity, and in addition to plants mentioned in previous figure the following occur : *Ficinia aphylla* Nees, *Passerina rigida* Wikstrom and *Cnidium suffruticosum* Cham. & Schl



10. *Phoenix reclinata* Jacq. on bank of pool in the Kap (Cap) River, *Cyperus latifolius* Thunb. in foreground.



11. Stream bank vegetation, not perennial flow of water, *Phoenix reclinata* in association with *Combretum caffrum* O.K., and nearby *Scutia myrtina* Kurz., *Plectronia* sp., *Doryalis rhamnoides* Harv., *Rhus MacOhrani* Schoul. and *Cyperus textilis* Thunb. in the water - Kap River.



12. *Prionium P. pulita* E. Mey. checking soil erosion in the bed of the stream which bears its name in Howiesons Poort, near Grahamstown.



13. Fynbos; rather early stage in transition from grass veld, having been damaged by fire: *Erica* spp., *Berzelia* spp., etc., coming in, at the same time threatened by invasion by the exotic tree *Pinus pinaster* Ait.: south slope of Mountain Drive, Grahamstown.



14. *Oldenburgia arbuscula* Less. in foreground on hard sandstone outcrop of Witteberg Series, and the exotic tree *Pinus pinaster* Ait. encroaching rapidly on grassveld: Mountain Drive, Grahamstown.



15. Grassveld interrupted by more or less parallel bands of *Oldenburgia arbuscula* Less. which shows a strong affinity for the hard sandstone outcrops of the Witteberg Series ; *Aloe lineata* Haw. in foreground ; south of Grahamstown.



16. Mixed scrub patch on high ridge of mountain overlooking Fish River valley towards Carlisle Bridge, *Encephalartos longifolius* Lehm. in centre.



17. Forest relic, Mifflord Park, near Riebeck East: fringing bush largely removed exposing *Podocarpus falcatus* R. Br., trunk 18 ft. in circumference, 4 ft. above ground level, some regeneration was evident in adjacent sites.



18. Scrub bush east of Riebeeck East: more woody than typical karroid scrub and more xerophytic than bush; *Aloe africana* Mill., *Gymnosporia* sp., *Placoxylon obliquum* Radlk., etc., occur.



19. "Aylesby" farm (Dr. S. Schonland) meagre rainfall supplemented by bore-hole water for household use and vegetable garden; scrub bush removed near homestead replaced by mixed Karroo shrublets and grass.





20. Karroid scrub: dense growth on "Penrock" farm in a valley draining into the main Fish River valley, *Aloe ferox* Mill. and *Scutia myrtina* Kurz. prominent in the foreground.



21. *Euphorbia polygona* Haw. with one plant of *E. inconstantia* R. A. Dyer about the middle, *Aloe ferox* Mill. and an exotic *Opuntia* in the background; Witteberg Sandstone outcrop, Bothas Ridge.



22. *Euphorbia polygona* Haw. with the more slender *E. inconstantia* as in previous fig., grass in rock crevices, *Jasminum multipartitum* Hochst. and *Polygala myrtifolia* L.



23. Due to interference of man scrub and karroid scrub are being replaced by Karroo shrublets, the fallen *Aloe* is a step in this direction; 6 to 8 miles north of Grahamstown.



24. Relics of scrub veld which has given way to Karroo veld due to interference of man; same areas as previous fig.; *Scholia speciosa* Jacq.



25. Same areas as figs. 23 and 24: a dense stand of *Ornithogalum thyrsoides* Jacq. (chinchinchee).



26. Karroid scrub: Hell Poort, *Aloe speciosa* Bak., *Euphorbia inconstantia* R. A. Dyer., *Portulacaria afra* Jacq. and various other characteristic succulents and xerophytic shrubs.



27. Karroid scrub: dwarf *Euphorbia* growth, *E. bothae* Lotsy p.h. and *Pappia capensis* E. & Z. prominent; otherwise largely grazed out, Committees Flats leading to isolated hill.



28. Karroid scrub: hill shown in previous fig. 27; stemless *Euphorbia* replaced by the shrub or small tree *E. curcivama* R. A. Dyer, woody constituents dense and occasional relics of a more temperate flora, e.g. *Heteromorpha arborescens* Cham. & Sch:



29. Karroid scrub : featuring *Euphorbia curvirama* R. A. Dyer, on hills above Hunt's Drift, Fish River valley.



30. Karroid scrub : associates of *Euphorbia triangularis* Desf. and *E. grandidens* Haw. : hills a few miles from Hunt's Drift.



31. Karroid scrub : associates of *Euphorbia grandulens* Haw. and *E. triangularis* Desf. : hills a few miles from Hunt's Drift.

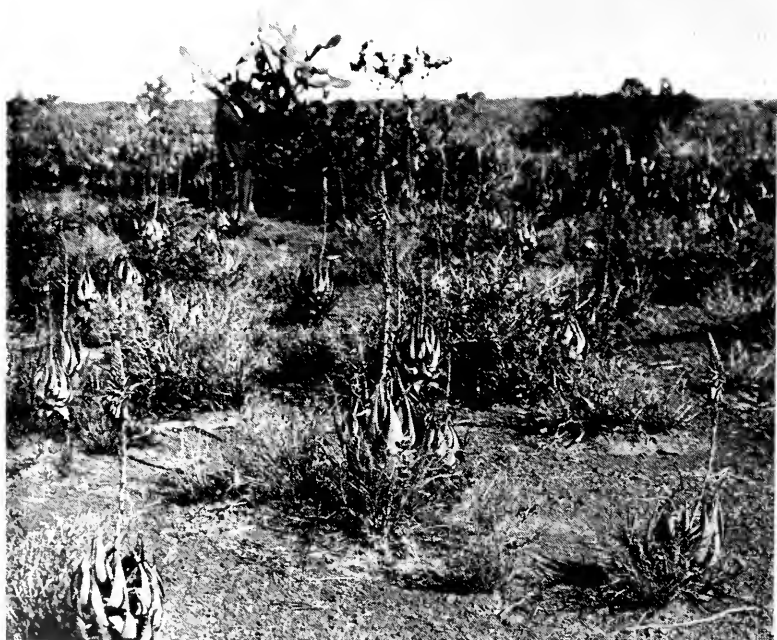


32. Karroo veld : Dikkop Flats near Carlisle Bridge, *Dimorphotheca Zeyheri* Sond. is in flower ; see Chart 1 and list of plants.

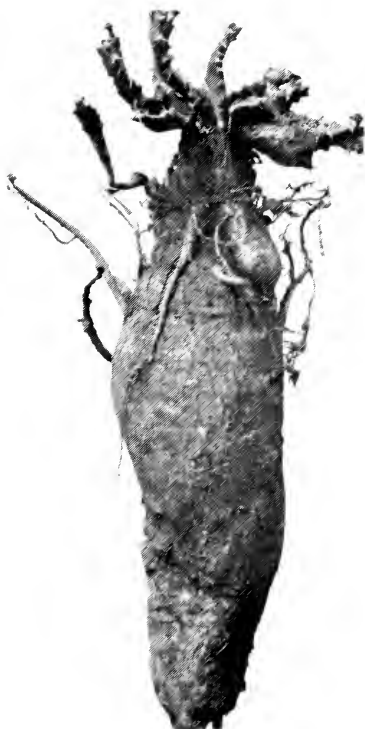


33. Junction between Karroo veld and karroid scrub : gentle slope up into Hell Poort from Dikkop Flats ; see Chart 2 and list of plants.

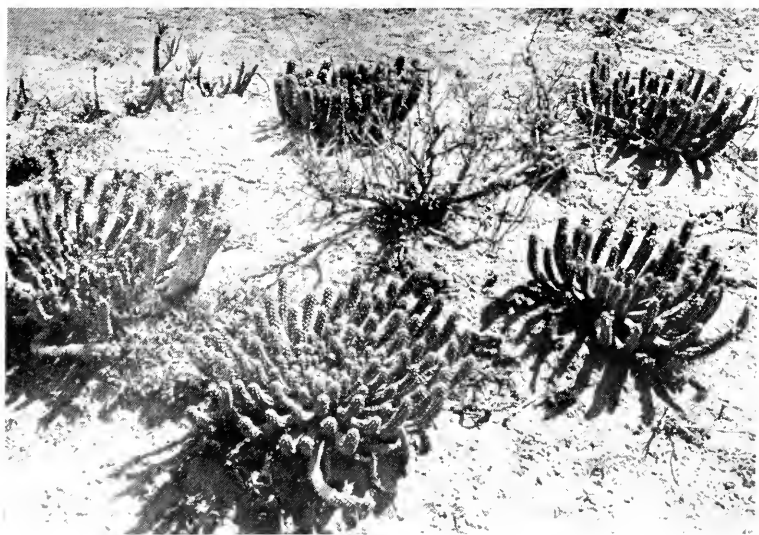




34. Karroo veld considerably tramped out : dwarf bushes similar to those listed for Chart I with dense association of *Alce microstigma*, exotic species of *Opuntia* in the background : Dikkop Flats near Carlisle Bridge.



35. *Euphorbia squarrosa* Haw. showing large root storage organ and few thin root growing upwards to near the ground surface for the purpose of benefiting from light rains.



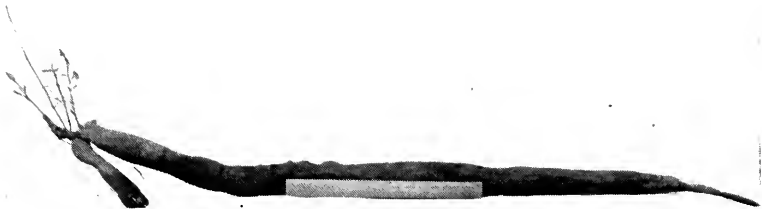
36. *Euphorbia inermis* Mill.: badly tramped out karroid veld: plants of *Pachypodium succulentum* DC. and *Mesembryanthemum* sp., which, like *E. inermis*, possess large underground storage organs, have not yet succumbed to the harsh treatment.



37. *Pachypodium bispinosum* DC. in karroid veld, showing part of large root storage organ, associated with *Cotyledon* sp. and *Crassula lactea* Ait.



38. Karroid veld; roadside cutting showing nature of soil and roots penetrating 10 to 12 feet and more; Plutos Vale.



39. Fleshy root-storage organ over 3 feet long of *Ipomoea argyreioides* Choisy shown in Fig. 40.



40. *Ipomoea argyreioides* Choisy with beautiful flowers, persisting in tramped out karroid veld, partly due to large root storage organ shown in Fig. 39.



41. Grassveld : effect of different kinds of stock on similar veld ; near camp, grazed almost entirely by sheep, infested with *Selago corymbosa* L. : further camp grazed by all classes of stock on Grahamstown town commonage (Dyer : 1932) *Selago corymbosa* absent.



42. Re-established "rooigras" veld, *Themeda triandra* Forsk. on old "kweek" lands, *Cynodon Dactylon* Pers. : this remarkable result was obtained by Mr. T. Hoole, Mitford Park, near Riebeck East, within a period of 3 years by broadcasting rooigras in seed and burning once.









UNION OF SOUTH AFRICA

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Department of Agriculture and Forestry

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DIVISION OF PLANT INDUSTRY

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# NOTES ON THE VEGETATION OF THE KAMIESBERG

BY

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# NOTES ON THE VEGETATION OF THE KAMIESBERG.

By R. S. ADAMSON.

The Kamiesberg, which forms the highest land in Namaqualand is a part of South Africa which is very little known botanically. The flora has been studied to some extent though by no means exhaustively but there seem to be no data available on the relationships of the vegetation.

The first serious botanical study was that of Drège in 1829-30. The collections then made, principally in the vicinity of Leliefontein, form the basis of knowledge of the flora. In 1908-9 Pearson traversed the eastern flanks of the range. In 1910-11 he explored the central parts and made notes on the features of plant distribution which do not seem to have been noticed by later workers who have made vegetation maps including this region. Otherwise there seems an absence of any records dealing specifically with these mountains.

The present account is a reconnaissance which takes note of the central part of the Kamiesberg range which extends from Garies in the south to the Buffels River in the north. The ridges running parallel to the main one but further inland (east) have not been explored.

## ACKNOWLEDGMENTS.

This investigation was carried out with the aid of a grant from the Botanical Survey of South Africa. I take this opportunity of expressing thanks to the Revd. J. A. George of the Methodist Mission at Leliefontein for much local information, for rainfall data, and for his hospitality during visits to the mountains. I have also to thank Mrs. M. R. Levyns for information collected on a spring visit to Leliefontein that has been put at my disposal.

## GENERAL.

The Kamiesberg which forms a sector of the escarpment of the interior tableland of South Africa is a mountain system rather than a single range. The highest ridge forms the escarpment itself and rises steeply from the coastal plains. This ridge forms a plateau 3,000 to 3,500 ft. in altitude which rises in the central part to over 4,000 ft. (4,700 at Leliefontein). From the plateau rocky and often rounded hills project. Some account of the topographic features and of the peaks was given by Anson-Cook in 1931. The highest points are Sittensberg 5,650 ft., Ezelkop 5,477 ft., Leliefonteinberg 5,310 ft. (the heights are taken from "List of Summits" in Journ. Mt. Club S. Afr. XXXV. 136, 1932).

Eastwards from the main ridge are a series of lower ridges which gradually merge into the tableland of Bushmanland. The Kamiesberg is bounded on the north by the basin of the Buffels River which forms a distinct bay in the escarpment line. This river forms the main drainage for the mountains though there are also a number of streams with a general SW. trend that run down the escarpment. Neither the Buffels River nor these streams carry water throughout the year. There are a number of springs on the plateau and mountains which are permanent though few have a sufficient flow to maintain streams.

#### GEOLOGY.

The whole area is mapped as built up of Old Granite. The rocks are gneiss-like, often pinkish in colour, with considerable variation in texture. Some are very coarse grained, other much finer. The latter are more resistant to weathering and build up the elevations. Bands of harder, finer grained rock of varying size run through the main mass in various directions. The rocks have a tendency to weather by the separation of concentric shells. This results in rounded or conical hills at times of large size, which often have smooth rock surfaces on their sides.

#### SOILS.

No detailed examination of the soils has been made. The uniformity of rock gives a certain uniformity of soil. The peaks have little soil but deeper accumulations occur on the plateau in the intervening parts. Few of these soils appear to be mature: they are generally rather coarse grained, sands or fine gravels, all with a high proportion of larger materials. In colour they are pale pink or yellow, and have no distinct darker surface layers. Concretionary zones appear to be absent. At the foot of the escarpment and in the Buffels River valley different soils are found; these are the type characteristic of arid regions. They are bright red, orange, or yellow soils which are often fine grained. These arid soils are commonly alkaline and some may have an actual deposit of salt crystals at the surface. Black or dark coloured soils are confined to rock pockets or to the immediate vicinity of water supplies. Near a permanent spring at Leliefontein soils of a Podsol type occurred locally. On the plateau and mountains wind erosion of soil is an important factor in the removal of the finer particles. The effect of wind erosion is often apparent on rocks. On the windward side of projecting rocks there are commonly flat or shallow basin shaped patches of gravel which are bare of plants. Wind erosion is especially noticeable on burned parts and in arable land. Drifts of sand accumulate on the lee side of the latter.

#### CLIMATE.

The climatic conditions vary considerably with altitude. The more elevated portions have increased precipitation and lower temperatures. Though very few data are available for the climate, it can be shown that the vegetation forms a very useful indirect guide.

## RAINFALL.

Though stations where rainfall is recorded are few it is fortunate that at Leliefontein on the highest part of the plateau, and at Garies at the foot of the escarpment records have been kept for a large number of years. Springbok, though outside the area immediately studied, has also a long record and is added as an illustration of the conditions in the north of the range. At none of these stations is the rainfall high: Garies is definitely arid. Average figures for the three are:—

Leliefontein	4,700 ft.....	12·72 in.	323·0 mm.
Springbok	3,200 ft.....	9·60 in.	243·8 mm.
Garies	830 ft.....	4·99 in.	126·7 mm.

From the characteristics of the vegetation that are described it is evident that the rainfall decreases rather rapidly to the east of the main ridge.

TABLE I.  
AVERAGE ANNUAL RAINFALL.

	Leliefontein.		Springbok.		Garies.	
	in.	mm.	in.	mm.	in.	mm.
January.....	0·29	7·4	0·06	1·5	0·04	1·0
February.....	0·49	12·4	0·15	3·8	0·11	2·8
March.....	0·34	8·6	0·49	12·5	0·10	2·5
April.....	0·95	24·1	0·51	12·9	0·45	11·4
May.....	1·27	32·3	1·14	29·0	0·52	13·2
June.....	1·86	47·2	2·15	54·6	0·77	19·6
July.....	1·16	29·5	1·21	30·7	0·60	15·2
August.....	2·73	69·3	2·20	55·9	1·16	29·5
September.....	2·03	51·6	1·15	29·2	0·75	19·1
October.....	1·05	26·7	0·19	4·8	0·10	2·5
November.....	0·32	8·1	0·24	6·1	0·32	8·1
December.....	0·23	5·8	0·11	2·8	0·07	1·8
Year.....	12·72	323·0	9·60	243·8	4·99	126·7

TABLE II.  
RAINFALL AT LELIEFONTEIN.  
Maxima and Minima for 24 Years.

	Maximum.		Minimum.	
	in.	mm.	in.	mm.
January.....	1·90	48·3	0·00	0·0
February.....	3·86	98·0	0·00	0·0
March.....	2·64	67·1	0·00	0·0
April.....	5·44	138·2	0·00	0·0
May.....	3·56	90·4	0·00	0·0
June.....	10·69	271·5	0·29	7·4
July.....	4·30	109·2	0·27	6·9
August.....	5·87	149·1	0·21	5·3
September.....	5·84	148·3	0·00	0·0
October.....	2·61	66·3	0·00	0·0
November.....	2·70	68·6	0·00	0·0
December.....	0·86	21·8	0·00	0·0
Year.....	20·68	525·3	7·40	188·0

At each of the three stations the rainfall has a decided concentration in the winter: at least 80 per cent. falls between April and September (Table 1). Precipitation is, however, very irregular both in total and in distribution. During a 24 year period at Leliefontein the annual total varied between 7.40 in. (188.0 mm.) and 29.68 in. (525.3 mm). Table 2 gives an illustration of the variation in distribution during this period. On the average, August is the wettest month but the highest recorded monthly figure fell in June. During the past 24 years only three months, June, July, August, were never completely without rain. Absence of rain occurred 10 times in January and December, 13 times in February, 6 times in March and November, 3 times in April and May, and once in September. In any one year the number of dry months ranged from five to none. Periods of continuous drought are irregular in occurrence: the distribution within the period is given below:—

TABLE III.

DROUGHT PERIODS AT LELIEFONTEIN.

Periods of consecutive dry months.	1.	2.	3.	4.	5.	6.
Number in 24 years.....	23	4	2	2	1	1

These figures for the plateau show that prolonged droughts are not at all usual: on the plains they are much more frequent.

HUMIDITY AND CLOUD.

No published records are available, but the tendency is undoubtedly to rather low values and especially so at the lower levels where cloudless skies are very common. At the higher altitudes more moisture is present and mists occur from time to time both in winter and in summer. Though these mountains are outside the area influenced by south-east clouds, during a fortnight in December when no rain fell mists settled on the summits over 5,200 ft. on two occasions; once for a few hours only, the other for over twelve hours.

TEMPERATURE.

There are no stations within the area where records are kept. From general observation and scattered readings it is evident that the plateau has lower temperatures throughout the year. In winter frosts are frequent at levels above 3,500 ft. Radiation is considerable and the daily temperature range is high, especially at the higher altitudes.

WIND.

On the plateau and mountains wind is general though not violent and serves materially to mitigate the temperature. Breezes from the sea are the most frequent in summer. Easterly winds blowing over the arid interior occur at intervals and are sometimes accompanied by high temperatures and low relative humidity. The winter rains come with north and north-west winds: summer rain may come from the east and south-east. Summer rains may be heavy but are never prolonged.

Actual records of wind have been kept at Port Nolloth on the coast which here runs SSE.-NNW. For present purposes the published wind figures are grouped as sea breezes (SSE.-NW.) and land breezes (NNW.-SE.). The following table gives the values at sea level, at 1,000 m. (3,281 ft.), and at 2,000 m. (6,562 ft.) for January, February, and June, July. The figures represent frequencies per 1,000.

TABLE IV.  
WIND AT PORT NOLLOTH.

	Sea (SSE.-NW.)	Land (NNW.-SE.)	Calm.
Sea Level.			
January.....	886	45	68
February....	777	0	222
June.....	500	279	221
July.....	505	393	99
1,000 m.			
January.....	439	558	0
February....	305	690	0
June.....	244	762	0
July.....	201	799	0
2,000 m.			
January.....	384	613	0
February....	376	625	0
June.....	397	598	0
July.....	572	486	0

#### VEGETATION.

In the descriptive notes that follow, no attempt is made to give an enumeration of the species making up the different communities. Not only are the numbers large but the flora of the Kamiesberg is still far from adequately studied. Even among the commoner plants are several of which the identity is uncertain. The general characters of the vegetation are described below. It is hoped later to make a more detailed study of the flora and vegetation and to be able to fill up the gaps in what at the moment is an outline.

For descriptive purposes the vegetation, which shows an exceedingly close correlation with climate and habitat conditions, may be divided into divisions that correspond with topographic regions. These are the plateau with its peaks, the northern slopes descending to the Buffels River, the escarpment slopes, and finally the eastern ridges.

#### PLATEAU.

The plateau comprises the higher ground, generally over 3,500 ft., extending from Roodeberg (Rooiberg) in the south to Sneeuwkop which lies NW. of Kamieskroon in the north. The middle portion with Leliefontein at its centre is the highest and has the greatest rainfall.

The vegetation of the plateau falls into two divisions differentiated on soil characters, namely that of the peaks and rocky parts with very shallow soils, and the intervening parts with deeper soils.



The peaks themselves exhibit such close correlation in vegetation with topographic and climatic features that the former can conveniently be used for the classification of the communities.

#### PEAKS : UPPER SLOPES.

The characteristic vegetation on the upper parts of the higher peaks is a closed or almost closed bush community that is distinctly stratified. The bushes are largely ericoid or with small, hard, persistent leaves. In its full development the community may be three layered. The largest bushes reach 5 to 7 ft. but never form a continuous stratum, they are : *Leucospermum cartilagineum*, *Erica* sp. cf. *E. Plukenetii*, *Rhyticarpus difformis* and *Cliffortia ruscifolia*. There is a considerable variety of species in the second layer which is much denser and about 3 to 4 ft. Among the most abundant are : *Anthospermum tricostatum*, *Chrysocoma sparsifolia*, *Cullumia rigida*, *Erica verecunda*, *Indigofera spinescens*, *Metalsia muricata*, *Passerina glomerata*, *Selago glutinosa*. The ground layer is continuous or nearly so and dominated by *Restio Sieberi* with some other species, together with tufted *Cyperaceae*, some grasses and herbs. Some larger plants occur such as *Pentameris speciosa* and *Peucedanum* sp. aff. *P. ferulaceum*. On rocks and shallow soils in this community *Barosma Niveni*, *Diosma vulgaris*, and *Pteronia camphorata* are frequent.

This multi-layered community which represents the climax development at the upper levels is by no means extensive. It is limited to those places with a certain amount of soil and protected from fire for a number of years. A simpler community like the above but without the uppermost stratum is much more commonly found. The ericoid bush community with a closed ground layer though a stage in the full development, is the ultimate phase on very shallow soils and very steep slopes.

This type of community is only developed on the higher peaks. At lower levels it is only found in specially sheltered spots on south facing slopes.

#### COMMUNITY OF EXPOSED SUMMITS.

At the extreme summits of the higher hills, for example Ezelkop, a different community is developed, a dense low bush, not over 2 ft. high, in which the branches are densely interwoven in a continuous layer. The commonest plants are : *Cullumia rigida*, *Cliffortia ruscifolia*, *Metalsia muricata*, *Phylla montana*, *Peucedanum* sp. aff. *P. ferulaceum*, and *Selago glutinosa*. Less frequent are : *Barosma Niveni*, *Lobostemon glaucophyllus*, and others. The growth is extremely dense and of even height. No under layer is formed ; some of the plants of the ground layers occur here, especially *Restio Sieberi*, among the low bushes. This low bush on the summits appears to be a reaction to continuous wind exposure combined with absence of soil. It is only on the more rocky and steep sided hills. On those with flattish tops the bush of the upper slopes is continuous over the summit.

#### SLOPES.

The vegetation of the slopes below 5,200 ft. is similar to that described above but simpler. Not more than two strata are formed and the ground layer is rarely continuous.

The actual composition and structure of the communities shows considerable variation with altitude, aspect, and other factors.

On south facing slopes there is a more luxuriant bush of a more moisture demanding type. As an illustration of some of these features a transect was made of Leliefonteinberg from south to north. This is a rocky hill rising about 500 ft. from the plateau. The lowest broken rocky slopes on the south facing side were covered by a mixed bush in which *Eriocephalus pubescens*, *Elytropappus rhinocerotis*, *Athanasia* sp. (?n. sp.) *Cliffortia ruscifolia* were the most abundant though many others were frequent. The ground was largely bare. One hundred feet further up, *Diosma vulgaris* and *Pteronia incana* were abundant with *Aster fruticosus* along with *Eriocephalus* and other species. *Elytropappus* was rare. *Restio Sieberi* occurred as occasional tufts. Higher up the ground layer became progressively more continuous and the bushes denser and more varied. At 100 ft. from the top the characteristic ericoid community of the upper slopes was developed. The fully developed climax with large bushes forming a third layer was local here and only occurred in small patches.

On the north facing slopes the gradient was less. The vegetation in the upper part had *Passerina glomerata* very abundant or even locally dominant and the ground layer was discontinuous. The *Restionaceae* and species of other families formed separated tufts and not a real covering. *Passerina glomerata* *Cliffortia ruscifolia*, *Callunia rigida*, *Anthospermum tricoctatum* and *Diosma vulgaris* were much more abundant than on the south slopes. *Osteospermum* sp. aff. *O. moniliferum*, *Brachycarpacea varians* and *Helichrysum* sp. were abundant plants not seen on the other aspect. *Chrysecoma sparsifolia*, *Peucedanum* sp. aff. *P. ferulaceum*, and others were lacking. On the lower north facing slopes *Pteronia incana* and *Relbunium sedifolia* were abundant in a one layered mixed open community. *Passerina* continued to the base but became less frequent at the lower levels. *Rhus horrida* became very abundant at the base.

Similar and even more extreme aspect effects can be seen on other peaks. On the middle north facing slopes of Ezelkop *Passerina glomerata* and *Diosma vulgaris* were extremely abundant or almost dominant in a community with a continuous ground layer in which *Restio Sieberi* and *Tetraria* sp. were very common. *Osteospermum* was frequent in this bush. The much greater density and continuity of the ground layer here is an expression of the increase in moisture as compared with corresponding levels on Leliefonteinberg. Ezelkop stands right on the escarpment and receives greater precipitation and certainly more mist.

#### TALL BUSH.

Under steep rocks on south and south-east facing slopes there occurs a community of large bushes or even small trees which though limited in area is striking in appearance. The plants are larger and many have larger flat leaves. Among the commonest are *Gymnosporia laurina*, *Olea verrucosa* and *Kiggelaria ferruginea*, with *Royena hirsuta*, *Dodonaea Thunbergii* and others. Along with these are smaller bushes such as *Cliffortia ruscifolia*, *Malvastrum asperinum*, *Rhyticarpus difformis* and many others. Together they build up a very dense community.

Other plants characteristic of this bush are: *Ballota africana*, *Chironia baccifera*, *Cineraria aspera*, *Lobostemon* sp. *Senecio vestitus*.

#### CHOMOPHYTE COMMUNITIES.

The bare exposed rocks which may form extensive slabs are a characteristic feature of these hills and carry a special plant covering. Plants are confined to cracks, pockets of soil or broken places. Succulents, mostly of small size, predominate, though bushes, isolated or in groups occur wherever conditions permit. At the higher levels the cushion plant *Othonna retrorsa* is frequent but does not appear to flourish below about 5,200 ft. On these rocks generally common plants are: *Anacampseros telephiastrum*, *Conophytum* 2 spp., *Cotyledon* 2 spp., *Crassula lycopodioides*, *C. perfossa* and 3 other spp., *Mesembryanthemum* 4 spp., *Othonna euphorbioides*, *Wahlenbergia Ecklonii*. Less common are *Aristida angustata* and *Danthonia stricta*, while limited to moist or sheltered spots are: *Mohria caffrorum*, *Nemesia* sp., *Oftia revoluta*, and *Pelargonium scabrum*. Many others occur more locally along with representatives of the surrounding bush communities. These chomophytic communities with their succulent habit and open structure must be regarded as pioneer stages in the normal development but as stages to some extent stabilised owing to the absence of soil. The full story of the development has not been traced but it appears that simple bush communities dominated by *Diosma vulgaris*, *Cliffortia ruscifolia* and *Euryops lateriflorus* would follow the chomophyte pioneers. *Diosma*, for example, is dominant round the margins of most of the rocky outcrops on the plateau and grows on very thin soil. As soil is accumulated further plants get a foothold and the more varied and more complex communities are built up. Some cases were seen where *Cliffortia ruscifolia* and *Euryops lateriflorus* were present as tall, drawn up, unbranched plants in a dense bush of *Passerina*, *Erica* and *Leucospermum*. The plants had all the features of gradual suppression and elimination by the later arrivals.

#### LOWER HILLS.

On the hills of less elevation, that form offshoots on the east side of the main ridge, a rather drier and more open type of bush is developed. This has a quite incomplete ground layer and the main stratum is less continuous. The species present are the same as those on the lower parts of the peaks on the main ridge but the open structure gives a different general physiognomy. Even at the highest points on these ridges the vegetation is not closed. While most of the characteristic species are present they are scattered and in some cases dwarfed. For example, *Leucospermum cartilagineum* is found as isolated low bushes, not over 3ft. in places sheltered from the north. This vegetation undoubtedly represents a reaction to slightly decreased quantities of moisture. The decrease is not sufficient to alter the general composition but brings about this simplification in structure.

#### DEEPER SOILS OF THE PLATEAU.

Between the peaks and rocky outcrops is level or undulating ground with relatively deep soil. This part has a smooth surface: the valleys are broad and shallow and the ridges rounded.

## RHENOSTERVELD.

The vegetation on these deeper soils is rather uniform and dominated by the Rhenoster bush, *Elytropappus rhinocerotis*. Communities of this plant occupy practically all the more level areas of the plateau. The vegetation with its definite dominant and grey colour stands in sharp contrast with the dark coloured communities of the hillsides. From an elevation it is possible to distinguish the parts with deep soil or shallow soil by the colour of the vegetation. The Rhenoster bush communities have a rather regular upper layer: the branches of adjacent bushes may be in contact but the bases are well separated. Even at the crown level it is rare to find more than 70 per cent. of real cover. The height is uniform: 3 to 4 ft., occasionally as much as 6 ft. In all examples of undisturbed communities seedlings or young bushes of the dominants occurred with the older ones. Though *Elytropappus* is definitely dominant and gives the character to this vegetation, it rarely occurs alone but is associated in varying proportion with other plants. The commonest are: *Mundtia spinosa*, *Euryops lateriflorus* and *Eriocephalus pubescens*. One or more of these may share dominance especially on stony or shallower soils.

The undergrowth is generally sparse and never forms a complete ground cover. It consists of small bushes, creeping plants which are generally immediately under the bushes, annuals and geophytes. The following spectrum was constructed from a number of samples:—

Total Species.....	N.	Ch.	H.	G.	T.
68.....	23	31	20	6	20

The figures are percentages to the nearest whole number. As the lists were made in summer the figures for annuals and geophytes are certainly too small.

While the general appearance of the vegetation is of great uniformity a more detailed study shows a lack of real homogeneity. Out of ten samples the dominant, *Elytropappus*, was the only species present in all, and only four species were found in nine. The actual figures for the frequencies were as follows:—

Total Species	In 10	in 8-9	in 6-8	in 4-6	in 2-4	in 1
68.....	1	4	12	17	23	21

The rather low frequency figures are the result of sporadic distribution and of minor changes in habitat. Even in what appear to be uniform conditions a number of plants are very irregularly scattered.

Disturbance either by fire or otherwise has an influence; some species are rapidly eliminated by grazing for example.

The following table illustrates some of these variations in so far as they affect the most abundant bushes.

TABLE V.

RHENOSTERVELD.			
Sample.	Soil etc.	Character Plants.	Notes.
1.	Deep soil in valley	Elytropappus d. Creeping Plants a.	Light grazing
2.	Slope of ridge soil stony	Elytropappus Euryops Athanasia	} equally abundant
4.	Watershed. Some stones	Elytropappus Eriocephalus Mundtia	
5.	Deep gravel on ridge	Elytropappus Euryops Athanasia	} cd. va.
7.	Deep coarse sand on watershed	Elytropappus Anthospermum Mundtia	
			Undisturbed stable community.

## COMMUNITIES MARGINAL TO RHENOSTERVELD.

Where the rocky peaks descend steeply to the plateau the line of junction between Rhenosterveld and other communities is a sharp one, but more commonly a zone of transition occurs in which a community containing elements from both is developed. The Rhenoster bush is very abundant but much mixed with others: *Euryops lateriflorus* and *Salvia africana* are especially abundant. A number of plants generally found on the rocky soils spread into these transition zones, such as *Cliffortia ruscifolia*, *Phylica montana* and less commonly *Diosma vulgaris*. These marginal communities form a series of mixtures the composition of which depends on the local conditions. At the foot of peaks where a deep detrital soil which is often fine grained accumulates, a community quite or almost without Rhenoster bush may be formed. *Salvia africana* and *Eriocephalus pubescens* are the dominants under such conditions.

Among the marginal communities is one of greater extent which occurs on rocky places where soil fills the spaces between the rocks. Such habitats occur at the top of slopes descending from the plateau. The vegetation here is formed of rather large bushes which are drought resistant: *Euryops lateriflorus*, *Rhus undulata*, *R. horrida* are the most abundant. *Royena hirsuta* occurs against rocks. In the intervening spaces *Othonna divaricata* is very abundant. *Elytropappus* may occur where there are deeper soils but is not frequent.

## WATER-DEMANDING COMMUNITIES.

Situations with permanent water supplies are limited to a few streams and occasional springs. Here a distinct vegetation is developed which is a bush community with a tall grass-like undergrowth. *Psoralea* sp. aff. *P. oligophylla* is the dominant bush. In the undergrowth *Pennisetum macrourum*, *Carpha glomerata*, *Scirpus nodosus* and *Watsonia* sp. cf. *W. marginata* are abundant.

None of the streams is of sufficient size or permanence to support any dense bush. Small streamlets on the peaks are lined by herbaceous plants that often grow on moss cushions: *Felicia* sp. *Drosera* sp. *Monopsis campanulata*, *Juncus pictus*, *J. rupestris*, *Holcus setiger*, are especially abundant.

#### LOWER PLATEAU.

Both north and south of the central part the plateau descends about 1,000 ft. The lower portions have essentially the same vegetation but the communities are more open and several species characteristic of the higher altitudes are wanting or much less abundant. Rhenosterveld occupies the deeper soils but is more open and there are fewer associated species. The rocky slopes have *Rhus undulata*, *R. horrida* and *Montinia acris* as prominent constituents of one-layered communities. *Restionaceae* and plants of similar habit are rare or absent.

#### MODIFICATIONS OF THE VEGETATION.

On the lower part of the plateau there are European farms: the highest central portion is in a reserve for coloured people. As the plateau is the part where such population is established and where changes in vegetation have been mainly brought about, these changes will be noted here.

The chief agents of change in the vegetation are burning, grazing and cultivation of the soil. Cutting of trees for fire wood and hut building has eliminated some stream side communities but is not an extensive factor.

#### FIRE.

Burning of the vegetation occurs rather frequently as is the case on all the mountain ranges of the south-western Cape. Though fires here are less numerous than further south there are few localities which do not show some signs of fire damage. On the steep sided hills with little available soil, regeneration after burning is rather slow. The loss of soil by wind and rain may result in the establishment of open communities of succulents which persist and are replaced very slowly by the later phases. The tall luxuriant bush of the upper slopes in which *Leucospermum* and *Erica* are prominent has suffered especially from burning. The present limited distribution is certainly the result of fire destruction. The commonly occurring mixed bush without the uppermost stratum is very often the ultimate stage that can be reached in the interval between fires.

Following a fire a large number of annuals and small plants become temporarily prominent: the actual species vary with the season of the fire and the distribution of rain following it. Burning in early summer results in a great spread of *Wahlenbergia namaquana*, *Pelargonium* sp. *Pentstemon patula*, *Achusa capensis* and others. There is no large increase in geophytes.

Where the soil is not removed, regeneration of bushes commences at once either from persistent basal parts or from seed. In one patch the following were noted 3 months after fire: Sprouting: *Lobostemon glaucophyllus*, *Mundtia spinosa*, *Stackys flarescens*, *Rhyticarpus difformis*, *Salvia africana*. Seedlings: *Athanasia* sp. (?n. sp.), *Dodonaea Thunbergiana*, *Eriocephalus pubescens*, *Malvastrum asperinum*.

Burning also affects the Rhenosterveld. The dominant bushes are killed but seed regeneration is rapid. The dominant regenerates more quickly than most of the plants associated with it and burned areas have a more complete dominance than old established ones. In the more open communities of the lower slopes fires are much more restricted in extent.

#### GRAZING.

Grazing is general except in the most remote parts, and near settlements may be severe. The indigenous grazing animals are not now abundant but domestic animals, donkeys, sheep, goats, and a few cattle and horses are kept. The first are much the commonest and cover far the widest area. Other animals are confined to limited areas around settlements.

The effects of grazing are twofold. Tramping creates paths and a general opening of the cover; consumption, which is selective, modifies the composition. The *Restionaceae* and other herbaceous plants are rapidly eaten down. The general effect of moderate grazing is to produce a less dense vegetation with a structure suggesting drier conditions than actually exist. When grazing is concentrated, as is the case round settlements, more profound changes are produced: complete destruction may result, and most of the settlements, and all these of coloured people, are centred in bare areas. As the settlements are on the deeper soils this destruction has been brought about in the Rhenosterveld. Such areas are quite devoid of woody plants or have a few isolated survivors chiefly against rocks. The only cover to the ground is made up of small herbs and annuals. *Gazania* sp. is the most important as a soil fixer and as supplying continuous supplies of fodder. With it are *Chaetobromus dregeanus*, *Lasiochloa* sp., *Danthonia* sp., and a few others. Of the annuals *Schismus fasciculatus* and the introduced *Erodium moschatum*, *Rumex acetosella* and others are common. Occasional plants of *Asclepias fruticosus* and *Homeria* sp. stand up.

Near water an apparently denser vegetation occurs in the form of almost pure communities of a prostrate form of *Rumex Ecklonianus*. Such communities slowly spread out radially onto drier soils but never become very extensive.

In the denuded areas the only bushes that persist are *Royena hirsuta*. and *Rhus horrida* which are found against rocks. Round the margins of these areas is a zone of small Rhenoster bush which outwards passes gradually into the ordinary Rhenosterveld.

At the present time in practically all cases the destruction is advancing and the possibilities of regeneration cannot be traced.

#### CULTIVATION.

Cultivation is confined to the Rhenosterveld and has affected a large proportion of it. Really untouched patches only occur in places remote from settlements. On the higher portions of the plateau cultivated lands are often at considerable distances from settlements. This arrangement avoids the necessity for fencing and gives freedom from damage by animals. The principal crop is wheat, with oats and rye in less quantity. The crops are generally poor and very much affected by irregularities of rainfall distribution. The land cultivated by the coloured people is generally in small

plots and both preparation of soil and harvesting are done by hand. The principle of allowing land to remain fallow for periods is followed. The fallow areas are rapidly colonised by Rhenoster bush.

#### GENERAL FEATURES OF PLATEAU VEGETATION.

All the communities that occur on the upper part of the Kamiesberg have the characteristics of structure, life-form, leaf-type, and floristic composition, that are associated with the vegetation of the winter rainfall region of the south western Cape Province. They are undoubtedly to be grouped with the "Cape" vegetation or sclerophyll type. The rather simple structure of many is correlated with the low rainfall which in amount is near the lower limit possible for the development of this vegetation. The communities of the highest parts which have the largest amounts of moisture, are those that are most like the typical sclerophyll communities of regions of higher rainfall. The Rhenosterveld here appears to be a quite stable community and must be regarded as a climax under the climatic and soil conditions of the plateau. On the deeper soils there is no evidence of any replacement of rhenosterveld and there is certainly power of regeneration. On the hill slopes where *Elytropappus* occurs where sufficient soil can accumulate, the rhenoster bush does seem to be replaced in time by *Passerina* and others. This is, however, in conditions with a rather higher moisture value than on the flat parts.

#### SLOPES DESCENDING FROM PLATEAU.

The lower slopes of the mountains have a decreased available moisture in lesser rainfall and lower average humidity. The slopes descending to the Buffels River are more gradual than the western escarpment and on them the change in moisture is extended over a longer distance and consequently from the standpoint of vegetation the reactions are more apparent. These slopes are a broken series of ridges with valleys between. The highest ridges are on the west. The vegetation on them can for convenience be divided into three divisions though these grade imperceptibly into one another.

#### OPEN BUSH COMMUNITIES.

The upper portions of the slopes are covered by a bush community similar in some of the characters to that of the driest parts of the plateau but containing a larger proportion of succulent plants. The bush layer is open: very often the bushes are quite separate though local groups may form patches of continuous cover. A large number of the bushes have a grey colour, such as *Pteronia incana*, *Montinia acris*, *Lebeckia* sp. *Eriocephalus pubescens* and others. *Zygophyllum foetidum*, *Didelta* sp. and less commonly *Euphorbia* sp. and *Cotyledon paniculata* are generally scattered throughout. The Rhenoster bush is absent; even in patches of deeper soil it does not descend more than 200 to 300 ft. from the plateau level. *Rhus undulata* occurs wherever rocks are found and is conspicuous on account of its dark foliage. The height and density of the bush varies with altitude, aspect and soil. The lower layer is very open: *Pentzia incana* and small succulents are the most common, but together they do not cover more than 30 to 40 per cent. The proportions of the succulents to the total flora of this layer increases with the decreasing moisture.



The accompanying list which includes only perennial species, will illustrate some of the varieties in this open bush.

TABLE VI.

## OPEN BUSH.

	NW. Exposure.	c. 3,000 ft.	NE. Exposure. 2,700 ft.
	Deep Soil.	Shallow Soil.	Rocky Soil.
<i>Acacia karroo</i> .....	stream-bed	—	stream-bed
<i>Aloe dichotoma</i> .....	—	—	r
<i>Antithrixia flavicoma</i> .....	—	—	o
<i>Atriplex albicans</i> .....	—	o	—
<i>Chrysocoma penduncularis</i> .....	—	—	o
<i>Cotyledon Wallichii</i> .....	—	f	o
<i>C. sp.</i> .....	—	o	o
<i>Crassula perfoosa</i> .....	—	o	o
<i>Cr. spp.</i> .....	—	3	2
<i>Didelta sp.</i> .....	o	o	o
<i>Eriocephalus pubescens</i> .....	a	f	o
<i>Euphorbia mauritanica</i> .....	—	—	f
<i>E. sp.</i> .....	f	f	o
<i>Galenia africana</i> .....	—	—	o
<i>G. sp.</i> .....	—	o	—
<i>Hermannia disermæfolia</i> .....	f	o	o
<i>Kiggelaria ferruginea</i> .....	—	rocks	—
<i>Lebeckia sp.</i> .....	—	—	f
<i>Melianthus minor</i> .....	—	o	—
<i>Mesembryanthemum</i> .....	3	5	4
<i>Othonna divaricata</i> .....	o	o	—
<i>Pelargonium sp.</i> .....	—	—	o
<i>Pentzia incana</i> .....	f	f	f
<i>Pteronia divaricata</i> .....	f-a	—	o
<i>Pt. incana</i> .....	—	o	o-lf
<i>Pt. sp.</i> .....	—	—	o
<i>Rhus horrida</i> .....	va	o-f	f
<i>R. undulata</i> .....	—	l	—
<i>Sarcocaulon sp.</i> .....	—	—	o
<i>Salvia africana</i> .....	f-o	—	—
<i>Tetragonia sp.</i> .....	o	—	o
<i>Tripteris sp.</i> .....	o	—	f
<i>Zygophyllum foetidum</i> .....	—	f	o
<i>Z. sp.</i> .....	—	—	o

In the area occupied by the open bush *Acacia karroo* is the characteristic plant along stream channels.

## KOKERBOOM COMMUNITY.

At lower levels *Aloe dichotoma* becomes a characteristic feature of the vegetation. Though the plant is not abundant and is mostly confined to rocky places its size makes it very conspicuous. The community in which it occurs, is a very open bush with numerous succulents: though there is diversity in size of the plants the sparsity of the cover eliminates any definite stratification. The commonest of the larger plants here are *Lebeckia sp.*, *Rhus horrida*, *Eriocephalus pubescens*, *Didelta sp.*, *Euphorbia sp.* and others. *Rhus undulata* occurs on rocks and in drainage channels. *Pteronia incana* occurs but is rarely

more than occasional. The smaller plants interspersed are predominantly succulent. Large numbers of annuals come up when conditions are favourable. In these communities are a number of plants that do not occur at all at the upper levels; among these are *Erythrophysa undulata*, *Heeria* sp., *Hermbsaertia glauca*, *Vogelia africana*. Though very distinct in its more extreme forms this kind of community passes insensibly into the Open Bush type at the upper levels. A more detailed study would probably show that several units are included in the Kokerboom community.

#### DRY BUSH.

This term is applied to a very open bush that occurs on the foothills and low kopjes in the river basin. The community is confined to rocky places and is very open with much bare ground. Succulents are less prominent than in the Kokerboom community; they occur on bare rocks and immediately below the bushes. The commonest plants are *Lebeckia* sp., *Montinia acris* and *Eriocephalus pubescens*. With these are isolated plants of *Heeria* sp., *Hermbsaertia glauca*, *Vogelia africana*, *Lycium* sp., *Solanum* sp., *Royena hirsuta*, *Pollichia campestris* and others. *Zygophyllum foetidum* and *Aloe dichotoma* occur occasionally. The bush layer made up of these and others is exceedingly open and covers much less than half the surface. Smaller plants occur below the bushes, in rock cracks, or between boulders: in addition to succulents, eg. *Crassula*, spp.- *Mesembryanthemum*, spp. and others, *Fingerhuthia africana* is rather common. In deep clefts there are *Enneapogon scaber*, *Forskohlea candida*, *Sutera pedunculosa* and others. This dry bush community represents the extreme reaction to drought of the bush types of the mountain slopes.

Where the low kopjes descend steeply to the more level soil covered ground, there is present a fringe of bushes of much larger size than elsewhere. Though quite a narrow belt this is conspicuous on account of the size and the dark colour of the leaves. The commonest plants here are *Rhus undulata* and *Ficus cordata*, with also in lesser quantities *Royena hirsuta*, *Lebeckia* sp., *Zygophyllum foetidum* and others. *Ballota africana* is abundant underneath the bushes. The bushes in such situations may reach a height of 6 to 8 ft. and form a quite continuous and dense layer.

#### KARROO COMMUNITIES.

On the more level ground with deeper soil are open communities of low growing succulents with large areas of bare soil and very numerous short-lived annuals. *Euphorbia mauritanica* is especially abundant near the hills *Mesembryanthemum* spp. elsewhere. The actual composition varies in accordance with the characters of the soil and others factors, exposure, slope, etc., A number of distinct communities are present but they have not been studied. Some of them are readily recognised; for example, pure communities of *Mesembryanthemum denticulatum* occur on shallow gravels and mark out these even when quite small patches. (cf. photo in Pearson 1913 p. 112). *Suaeda fruticosa* also forms pure communities which may be dense and almost closed, on alkaline soils in river beds. A number of species occur among these Karroo communities that are not found in the corresponding ones on the western plains: among these are *Aristida brevifolia* and *Peliostomum virgatum* both of which were locally abundant.

# ESCARPMENT SLOPES.

The west-facing escarpment slopes are very much steeper than the northern ones and fall to a lower level. The steepness renders the zones of vegetation less distinct from one another. While the series of communities is similar to that described, there are differences in addition to those due to the telescoping on account of steepness. The upper regions are moister than the tops of the northern slopes and have a rather more luxuriant growth. Especially where mountains rise directly on the escarpment a complete series of gradation can be traced from the communities of the higher peaks at the top to succulent semidesert at the bottom with no sharp dividing lines at all.

In a general way the upper parts have an open bush vegetation with some large succulents, like that described above. The community is often denser and *Relhania sedifolia* shares dominance with *Pteroma incana*. *Cotyledon paniculata* is locally frequent. *Rhenoster* bush occurs in patches of deeper soil and descends 700 to 800 ft. from the plateau level. As an example of the gradations that occur, the vegetation on the slopes east of Garies may be quoted. On a SW. exposure at 2,500 ft. there was a mixed bush in which *Salvia africana*, *Relhania sedifolia*, *Pteroma incana*, and *Rhus undulata* were the most abundant plants. *Passerina glomerata*, *Didelta* sp., *Dodonaea Thunbergiana* and *Elytropappus* were occasional. The ground layer was sparse and composed of small succulents, a few tufted grasses, and annuals. Three hundred feet further up *Erioccephalus pubescens*, *Lobostemon glaucophyllus* and *Gnidia nitida* became rather abundant with *Restio Sieberi* occasional below. Ascending a further 250 ft. *Pteronia* and *Relhania* were much less abundant and the succulents were confined to rocks. The dominants were *Passerina*, *Erioccephalus*, *Cliffortia ruscifolia*, and *Athanasia* sp. (?n sp). Along with these were *Aster fruticosus*, *Rhyticarpus difformis*, *Gymnosporia buxifolia* and other species characteristic of the higher altitudes including occasional plants of *Erica* sp. cf. *E. Plukenetii* and *Metalsia muricata*. The ground layer was much richer and more complete, it included *Restio Sieberi*, *Chironia baccifera*, *Ehrharta aphylla*, *Rochea odoratissima*, *Melica racemosa*, *Helichrysum* sp., *Felicia* sp.

About half way up this slope was a dense growth of large bushes under a steep rock face, composed mainly of *Olea verrucosa*, some of which attained a height of 12 to 15 ft. Associated plants were *Rhus undulata*, *R. horrida*, *R. crenata*, *Dodonaea Thunbergiana*, *Pteronia divaricata* and *Cotyledon paniculata*. At lower levels the bush becomes more open and poorer in species and has small succulents abundant in the under layer. Some of the bushes characteristic of the upper parts become confined to stream beds and kloofs: *Rhus undulata*, *Olea verrucosa* and *Dodonaea Thunbergiana* are examples. As the base of the slope is approached the bushes become more and more scattered and small low growing plants take their place: *Pentzia incana* and succulents are the most common. At the base there is a change from a phanerophytic to a chamaephytic type of community. The latter is at first almost closed but becomes open lower down. *Aloe dichotoma* though never abundant here occurs in this chamaephytic zone. At the extreme base succulents become dominant; *Euphorbia mauritanica* is especially abundant at the foot of the rocky parts but smaller succulents are dominant on the deeper soils of the plains.

On the sides of kloofs on the escarpment communities characteristic of different altitudinal zones may occur in juxtaposition on north and south facing slopes.

In some of the larger valleys descending the escarpment there is a less varied series of transition stages. Large bushes predominate throughout with an increasing proportion and final dominance of large succulents towards the base. The larger drainage channels which carry water for a large part of the year have a tall bush or small tree vegetation. This stream side bush has a different composition at different levels. In the upper parts *Olea verrucosa*, *Freylinia oppositifolia*, *Kiggelaria ferruginea* are abundant; lower down *Euclea undulata*, *Royena hirsuta* and *Gymnosporia buxifolia* predominate; at the base *Acacia karroo* is dominant. *Rhus undulata* is common throughout and descends to the base.

#### EASTERN RIDGES.

Eastwards from the main plateau the rainfall decreases rather rapidly. No figures are available for this sparsely populated area but the increasing aridity in the structure of the vegetation gives a clear index of the facts. There are a series of ridges running parallel to the main escarpment which are 500 to 1,000 ft. lower than it. At present these have not been studied: a few notes on the first one which is 4 to 8 miles east are all that can be given. The highest points on this ridge are about 5,000 ft. The summits have a vegetation similar to that of the driest parts of the main plateau, an open bush with a discontinuous open and sparse ground layer. *Diosma vulgaris*, *Indigofera spinescens*, *Lobostemon glaucophyllus*, *Dodonaea Thunbergiana*, *Pelargonium scabrum*, and *Ostospermum* sp. cf. *O. moniliferum* are the most abundant. In the ground layer are isolated tufts of *Restio Sieberi*, *Zygophyllum* sp., and others. The slopes of these hills exhibit great differences in relation to aspect; those facing south have in the uppermost parts a rather close bush in which *Cliffortia ruscifolia*, *Anthospermum tricoatum*, *Athanasia* sp. (n. sp.) occur together with occasional plants of *Elytropappus*. On north-facing slopes at the same altitude a wholly different community was formed; a very open one with low bushes predominant. The very scattered larger bushes were *Eriocephalus*, *Pteronia incana*, *Lebeckia* sp. *Rhus horrida*, with *Othonna divaricata*, *Zygophyllum foetidum* and others. Of the smaller bushes *Galenia* sp. aff. *G. fruticosa*, *Pentzia incana* and *Tripteris* sp. were the most abundant. At lower levels the vegetation is of a more arid type with numerous succulents. Many of the plants characteristic of the upper parts become confined to rocky places on south-facing slopes. The general vegetation is very open.

At 1,500 ft. below the summits succulents become exceedingly prominent though scarcely dominant. Larger bushes are widely scattered: *Lebeckia* sp., and *Pteronia incana* are the commonest with *Pentzia incana* and other low bushes and succulents between. The bushes are closer on south-facing slopes where they may cover 50 to 60 per cent. of the surface. The bush cover was less than half this on a north aspect at the same altitude. The accompanying list from the slopes on either side of a col will illustrate these differences.

TABLE VII.

## EASTERN RIDGES.

	Life Form.	North Exposure	South Exposure.
<i>Antithrix flaricoma</i> .....	Ch	o	—
<i>Arctotis</i> sp.....	H	o	—
<i>Aristida angustata</i> .....	Ch	o	—
<i>A. ? capensis</i> .....	H	o	—
<i>Bromus patulus</i> .....	T	—	r
? <i>Boscia</i> sp.....	N	o	—
<i>Chrysocoma peduncularis</i> .....	Ch	o	f
<i>Crassula lycopodioides</i> .....	Ch (s)	f	r
<i>Cr.</i> sp.....	T (s)	—	o
<i>Cr. perfoassa</i> .....	Ch (s)	f	—
<i>Cotyledon Wallichii</i> .....	S	f	o
<i>C. cf orbiculata</i> .....	S	o	—
<i>C. aff. decussata</i> .....	S	o	r
<i>Dianthus scaber</i> .....	Ch	—	o
<i>Didelta</i> sp.....	Ch (s)	—	l
<i>Dodonaea Thunbergiana</i> .....	N	o	—
<i>Ehrharta calycina</i> .....	H	o	—
<i>E. gigantea</i> .....	Ch	r	o
<i>Elytropappus rhinocerotis</i> .....	N	—	l
<i>Euphorbia</i> sp.....	S	f	o
<i>Euryops lateriflorus</i> .....	N	—	f
<i>Eriocapulus pubescens</i> .....	N	o	o
<i>Picinia</i> sp.....	H	r	—
<i>Hermannia disarmacfolia</i> .....	Ch	o	—
<i>Leyssera gnaphaloides</i> .....	T	f	f
<i>Mesembryanthemum denticulatum</i> .....	H (s)	lf	o
<i>M.</i> sp. A.....	Ch (s)	a	o
<i>M.</i> sp. B.....	Ch (s)	f	o
<i>M.</i> sp. C.....	Ch (s)	f	—
<i>Othonna divaricata</i> .....	N (s)	o	—
<i>Pentstemon</i> sp.....	T	r	—
<i>Portia incana</i> .....	Ch	a-f	a
<i>Pharnaceum incanum</i> .....	Ch	o	—
<i>Pteronia divaricata</i> .....	N	r	o
<i>Pl. incana</i> .....	N	o	a
<i>Pl.</i> sp.....	N	—	o
<i>Rehmannia salifolia</i> .....	N	—	f
<i>Rhus horrida</i> .....	N	o	f
<i>Royena hirsuta</i> .....	N	o	o
<i>Salvia africana</i> .....	N	—	l
<i>Sclago</i> sp.....	Ch	o	—
<i>Stachys flarescens</i> .....	Ch	—	f
<i>Tetragonia</i> sp.....	Ch (s)	o	o
<i>Triphris</i> sp.....	Ch	o	—
<i>Wahlbergia Ecklonii</i> .....	Ch	o	—
<i>Zygophyllum foetidum</i> .....	N (s)	o	o

(s) = succulent.

N.B. The list is not complete for small plants, annuals etc.

While the communities on these ridges show similarities and parallels with those on the escarpment there are many differences which may be in part due to altitude. The slopes with the succulent type of community just described are at a height at least equal to that of the lower plateau. Further investigation of these communities is required before their relationships can be made out fully.

## RELATIONSHIPS OF THE VEGETATION.

In the entire absence of detailed work on this area any generalisations must be qualified by the possibility of subsequent revision. Though Pearson (1912) noted that the "Cape Flora" predominates at altitudes over 3,500 ft., on the vegetation maps that have been published this is not indicated. The whole area is included with the arid types that extend on either side of the range. For example, in 1920 Pole Evans mapped the area as part of the "Kokerboom Veld", a type that extends eastwards through Bushmanland and northwards to Great Namaqualand. In a more recent map (1936) "Desert Shrub", a generalised type that includes the whole Karroo area, is mapped as extending to the escarpment: the coastal belt is mapped as "Desert Succulents and Grass". This scheme is practically the same as that put forward by Bolus on purely floristic grounds, a scheme that is adopted for distribution in the later volumes of the "Flora Capensis". An arrangement very similar is adopted by Shantz in his generalised vegetation map of the whole continent of Africa. Most of these maps are certainly constructed on a scale so small that details cannot be included. However, in the 1936 map by Pole Evans the sclerophyll type of vegetation is marked as extending northwards as a narrow tongue along the crest of the escarpment of the Bokkeveld mountains but not on to the higher granite mountains of Namaqualand. From the descriptions given here it is evident that the upper parts of these mountains must be included in that type, the limit of which should be continued northwards at least to the rim of the Buffels River basin.

The classification of the communities on the slopes is perhaps more open to question. As has been pointed out there is a complete and gradual transition between the typical sclerophyll communities of the higher altitudes and the succulent semidesert ones of the lower parts. While the extremes are completely distinct the position at which a division should be made must be rather an arbitrary one and dependant on convenience. The rather open bush of the upper parts of the slopes is certainly more nearly related to the sclerophyll type in life forms and floristic composition and seems best treated as a dry sclerophyll. On the other hand, the Kokerboom communities and some of those of the eastern ridges, in their distribution of life forms and flora stand in a quite median position between the two types. They are clearly distinct from the typical succulent communities of the semidesert but are also remote from typical sclerophyll ones. In the region north of the Buffels River where the hills do not rise to the height of those to the south, Kokerboom communities occupy the elevations which get a slightly greater quantity of moisture whereas open succulent communities occur between them with very often a sharp line of junction between the two. If the series is traced in a downward direction these Kokerboom communities might be looked upon as the extreme reaction to aridity of the sclerophyll, but in the opposite direction they might as well be grouped with the succulent series.

On the Kamiesberg there is no indication of the sharp boundary which coincides with change of rock at the base of many of the mountain ranges covered by sclerophyll vegetation that arise in the arid region of the Karroo. There is here a quite gradual transition in climate, soil, and in vegetation.

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## DESCRIPTIONS OF PHOTOGRAPHS.

1. View of Ezelkop from the north-west showing bare rock surface.
2. Climax vegetation on north slopes of Ezelkop. *Leucospermum cartilagineum*, *Passerina glomerata*, *Erica verecunda*, etc. Chomophyte communities on rocks behind.
3. Summit of Ezelkop. Low dense bush: *Cullumia rigida*, *Selago glutinosa*, etc.
4. Lefiefontein. Denuded area in Rhenosterveld due to overgrazing. Open grazed Rhenosterveld in foreground. The trees are planted poplars.
5. North slopes of Kamiesberg. Open bush community.
6. Buffels River valley. Karroo vegetation with *Euphorbia mauritanica* and *Mesembryanthemum* in foreground. Kopje with Dry Bush behind. Fringe of large bushes, *Rhus undulata* and *Ficus cordata*, at its base.

